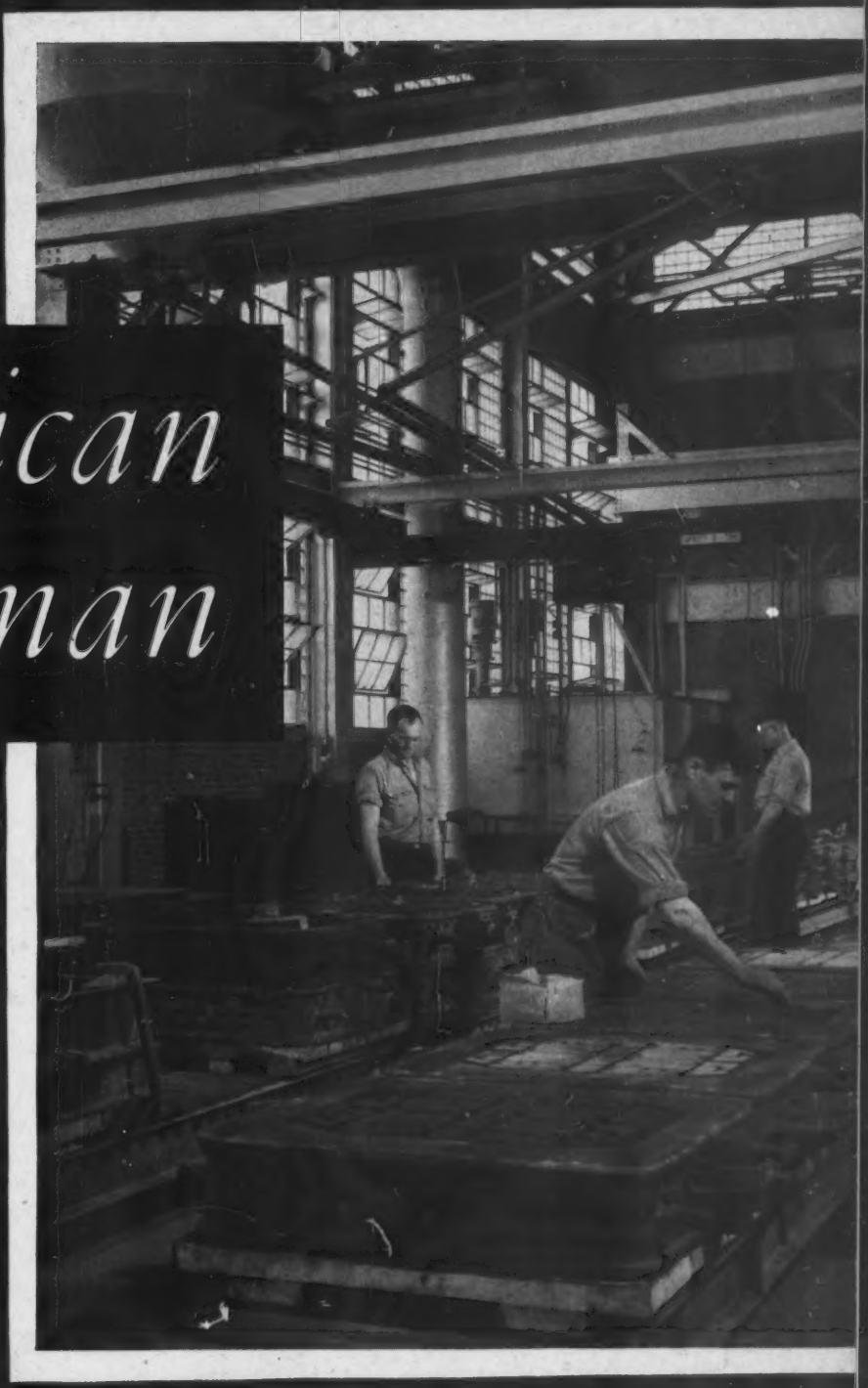
JUNE · 1948

# American Foundryman



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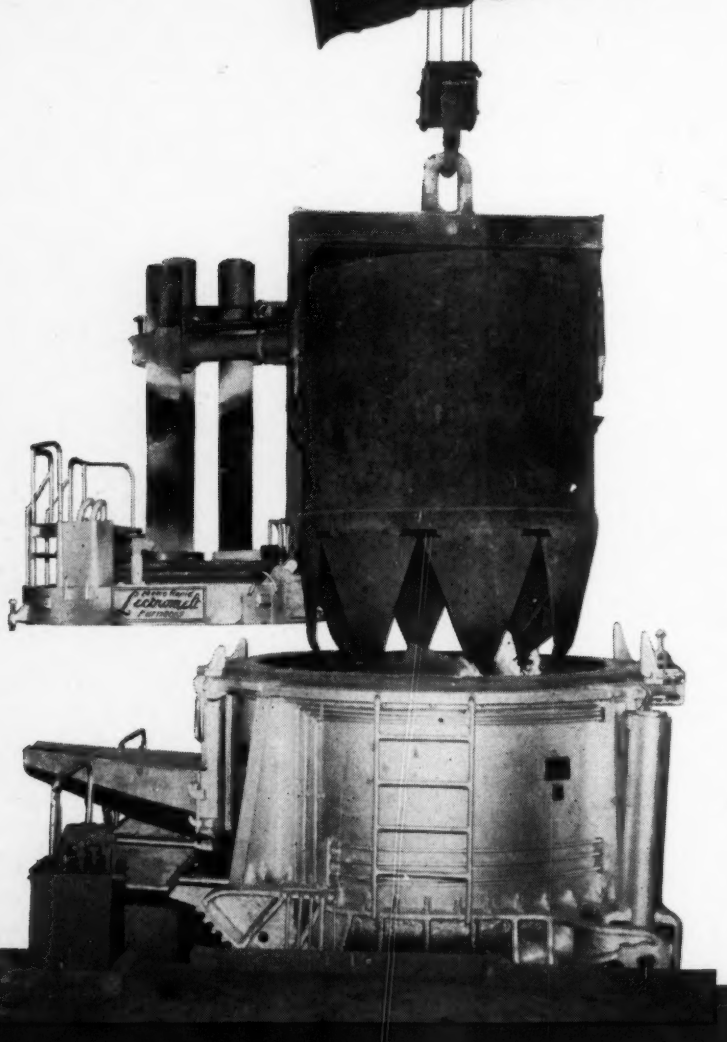

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# MANPOWER PROBLEM TESTS MANAGEMENT

FOUNDRIES THE WORLD over face a problem in manpower and some are solving it more or less successfully. On a recent trip to Europe I noted an appreciable number of younger men working in the shops. Investigation proved these young men to be four year apprentices.

Since returning I have talked with three different sets of visitors from abroad, asking their opinion of the conditions they find in foundries in this country. It has been surprising to note the uniformity of opinion expressed. In every instance they remarked at the lack of young men among the workmen in our foundries and were puzzled as to why we did not have an apprentice system in force, following this with the statement that they felt that we were going to meet a real crisis on skilled manpower in the foundries within the next ten year period.

Visitors from Europe marvel at the mechanization of our foundries and at the equipment that we have available. In general, the foundry industry in Europe today stands with a great lack of mechanized equipment but with an ample supply of manpower and with a strong apprentice plan in operation.

These contrasting conditions are the fruits of the type of management that we have had in the foundry industry in the United States. Top management here has been much concerned with the physical plant and equipment but has not devoted much time to manpower problems.

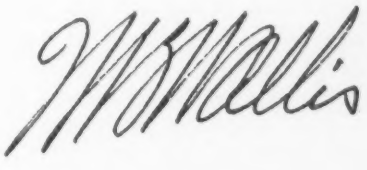
Management, in meeting its manpower problems, has not made full use of the possibilities, through the American Foundrymen's Association for educating foundry personnel. A.F.A. is a technical society operating 100 technical committees comprised of 500 of the best minds in the foundry industry . The products of the thinking of these men goes out to the membership of the Association through the AMERICAN FOUNDRYMAN and other publications of A.F.A. and through Convention and Chapter meetings.

The time has come—indeed, it has almost passed us by—when top management in the foundry industry must make available to the manpower in its plants the technical and practical information available only through membership of the individual in A.F.A. This will provide a real knowledge of the job being done that is so necessary to an active interest in the job itself. Without interest, a foundry job is simply a means of earning a livelihood.

Top management is well aware of the educational program that is being carried on by the foundry industry as a whole and perhaps is inclined to rely too much upon what it is doing in supporting that movement. This support is not enough for if the men now working in the foundry industry are not enthusiastically and intelligently interested in their jobs it will have a very depressing effect upon the young man on the outside, who has benefited from the educational program, when he comes to take a job in the foundry industry.

Top foundry management should examine the long range personnel problem, its own training programs, and determine how many of the men now in foundries are receiving monthly the information available through the American Foundrymen's Association.

Management seeking assistance should look to the A.F.A. five-point "new blood" program, the various recommended training programs, and to the benefits of Society membership for men in its plants.



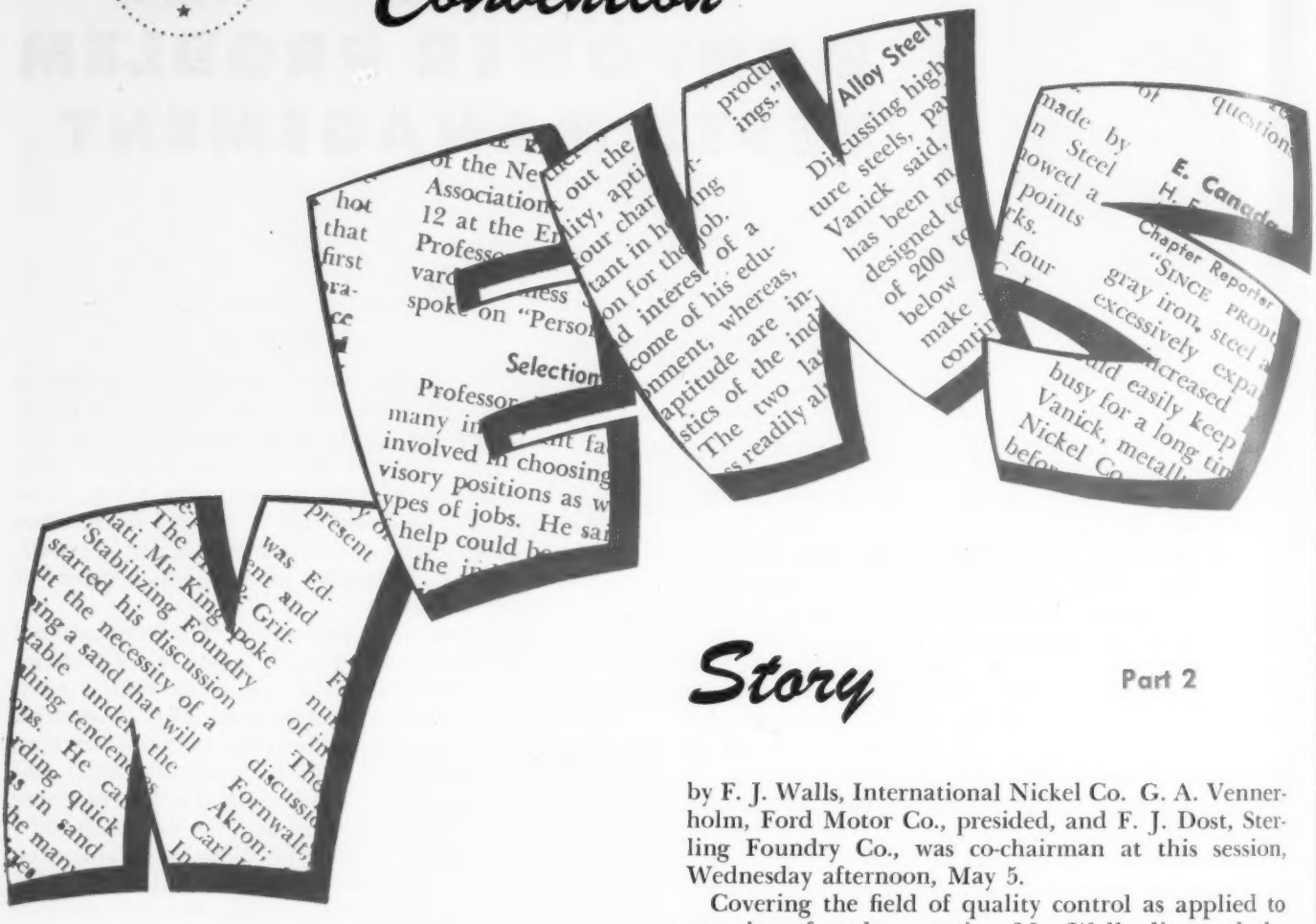
W. B. WALLIS, *President-Elect*

AMERICAN FOUNDRYMEN'S ASSOCIATION

WILLIAM B. WALLIS, *president, Pittsburgh Lectromelt Furnace Corp., was elected President of the American Foundrymen's Association at the 52nd Annual Convention in Philadelphia. Affiliated with the foundry industry for more than 36 years, he has made a number of business trips to foreign countries, and on his most recent trip visited in the British Isles, the Scandinavian countries, and parts of Western Europe, where he talked with many foundrymen. His observations of mechanization, foundry personnel, and foundry methods abroad have been the subject of a number of informal talks before A.F.A. Chapters.*

# Convention Story

Part 2




ONE OF THE MOST OUTSTANDING A.F.A. Foundry Congresses, the 52nd Convention in Philadelphia, May 3-7, has been acclaimed by foundrymen, exhibitors, and Convention visitors for the high quality of the technical sessions, shop course meetings, and exhibits. All sessions were heavily attended and in some meetings the audience was 2½ times larger than in previous years. Exhibits as well as technical meetings attracted convention attendance and one exhibitor reported he took 11 orders for a major piece of equipment in the first two days of the Show.

Continuing the report on the 52nd A.F.A. Convention and Show, first half of which appeared in the May issue of AMERICAN FOUNDRYMAN, the following story covers the meetings of the Gray Iron, the Brass and Bronze, the Aluminum and Magnesium Divisions, the Heat Transfer and the Foundry Costs Committees.

## GRAY IRON

Consisting of four Shop Course meetings, six technical sessions, and an Annual Lecture Series meeting, the program sponsored by the Gray Iron Division was the heaviest of the Convention. Unexpectedly large audiences required the technical meetings to be moved to the ballroom of Convention Hall.

The Annual Lecture Series paper, *"Test Procedures for Quality Control of Gray Iron Castings,"* was given by F. J. Walls, International Nickel Co. G. A. Vennerholm, Ford Motor Co., presided, and F. J. Dost, Sterling Foundry Co., was co-chairman at this session, Wednesday afternoon, May 5.

Covering the field of quality control as applied to gray iron foundry practice, Mr. Walls discussed the inspection of raw materials such as pig iron, scrap iron, sand, and coke. Importance of checking patterns, flasks, and other production equipment was brought out. Under process control, molding methods, venting, and mold hardness, gating and risering were discussed.

### Reviews Laboratory Procedures

In covering melting, fuels, and fluxes, Mr. Walls said that a reliable pressure gage on a cupola is an absolute necessity. Chill depth control was described under the use of ferro-alloy additions and inoculations. The spiral castability test was mentioned. Mr. Walls concluded his paper with a review of the chemical, mechanical, x-ray, and other laboratory procedures used to check quality of castings.

Gray Iron Shop Course meetings were held evenings, Monday through Thursday, to make them as convenient as possible for operating men to attend. Numbering approximately 400, the audience at each session was given first-hand information on gray iron production problems ,and had ample opportunity to quiz the speakers and participate in the discussion.

At the first session, T. W. Curry, Lynchburg Foundry Co., discussed *"Front Slagging of the Cupola"* and gave a thorough description of current methods considered most successful. E. J. Burke, Hanna Furnace Co., presided, with A. N. Kraft, Wilkening Mfg Co., as co-chairman.

*"Effect of Blast Variation on Cupola Control,"* by B. P. Mulcahy, consultant, aroused considerable discussion, at the second session the evening of May 4. Mr. Mulcahy's paper, which makes excellent application of theoretical principles to practical melting problems, appears on pages 34-42 of this issue of AMERICAN FOUNDRYMAN. H. H. Wilder, Eaton Mfg. Co., and B. A. Miller, Baldwin Locomotive Works, were chairman and co-chairman, respectively, at this session.

The Wednesday night Gray Iron Shop Course meeting provided a review of cupola coke by J. A. Bowers, American Cast Iron Pipe Co. W. W. Levi, Lynchburg Foundry Co., presided, and C. L. Lane, Florence Pipe Foundry & Machine Co., was co-chairman.

*"Factors Affecting the Fluidity of Cupola Iron"* were discussed by R. F. Flora, Clover Foundry, at the last session, over which K. H. Priestley, Vassar Electroloy Products Inc., presided, with Ralph Koch, U. S. Pipe & Foundry Co., acting as co-chairman. Discussion was lively and prolonged and centered on the relationship between phosphorus content of iron and fluidity. There was considerable divergence of opinion.

### Cites Need for Cupola Research

Leading off the first of the Gray Iron Division's six technical sessions, R. G. McElwee, Vanadium Corp. of America, spoke on *"Relation of Cupola Research to Progress in Cast Iron Development."* Chairman of the Cupola Research Committee and of the Gray Iron Division, Mr. McElwee explained the need for research work into cupola fundamentals and the importance of the cupola research activities currently sponsored by the American Foundrymen's Association. The relatively unexplored field of cupola control through slag color and consistency was covered in the discussion.

H. Edward Flanders, University of Utah, gave the second paper of the session, *"A Suggested Method for the Determination of Coke Reactivity to Carbon Dioxide at Combustion Temperatures."* Pointing out that the generally poor operation of cupolas in recent years has been attributed to the improper preparation of cokes for foundry use, Prof. Flanders described tests made to determine fundamental differences between good and bad cokes. Tests reported were made to measure the ability of a coke to give high temperature in a cupola. Basis of the tests was the analysis of combustion gases from a column of coke burning under adiabatic conditions.

*J. G. Pearce (left) of the British Cast iron Research Association and E. Longden, P. R. Jackson & Co., Ltd., Manchester, at the Foreign Visitors Reception, held the first night of the Convention, selecting the meetings and luncheons they expected to attend.*

V. A. Crosby, Climax Molybdenum Co., and D. E. Krause, Gray Iron Research Institute, were chairman and co-chairman, respectively.

A. E. Schuh, U. S. Pipe & Foundry Corp., presided, and F. G. Sefing, International Nickel Co., was chairman at the Thursday gray iron morning session.

### Describes Cast Iron Tests

A. B. Schuck, Koppers Co., Inc., described *"A Laboratory Evaluation of Some Automotive Cast Irons"* to an audience of over 200. He explained that the effect of cross section on the mechanical properties and metallurgy of cast iron often is not appreciated by the design engineer. Six types of alloy cast iron were made with varying carbon and silicon content and cast into test bars of square cross-section and varying size. Tests were then made of mechanical and thermal properties.

In a discussion of Mr. Schuck's paper, J. S. Vanick, International Nickel Co., commended the author for

*Foundrymen rated the 1948 exhibits as good as the best shown at any previous A.F.A. Foundry Congress and Show.*

*A section of the dual registration booth was set aside for the convenience of exhibitors' representatives.*

the useful data developed and pointed out that design engineers have a neat compromise to make between Mr. Schuck's conclusions that pearlitic, acicular, and drawn martensitic structures of the same hardness and having the same graphite flake size and distribution produce comparable wear resistance, and the conclusion that the impact resistance of acicular nickel-molybdenum irons is several times greater than the corresponding pearlitic materials. Mr. Vanick said that recent work in the International Nickel Co. laboratories indicates that acicular irons wear better.

### British Exchange Paper

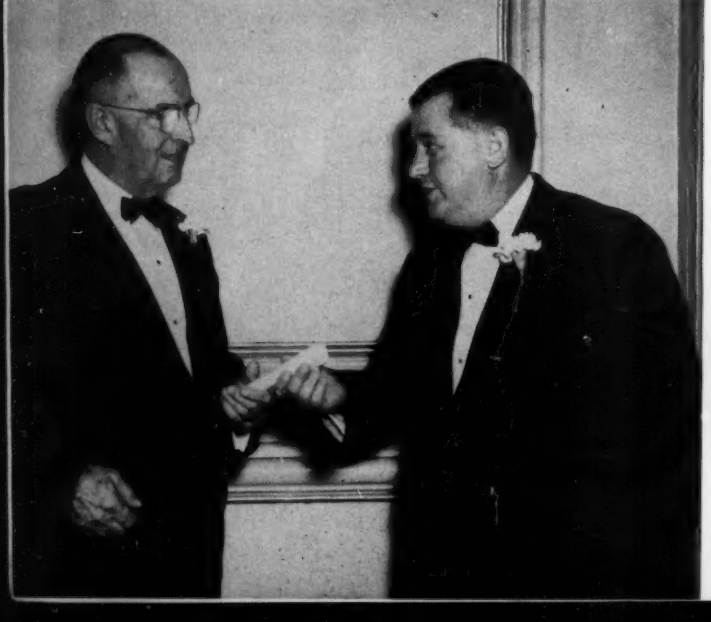
Second paper of the session, by E. Longden, P. R. Jackson & Co., Ltd., Manchester, England, was *"Contraction and Distortion in Gray Iron Castings,"* the official exchange paper of the Institute of British Foundrymen to the American Foundrymen's Association. Contraction problems are well known to all founders, said Mr. Longden, but certain classes of castings present more than average hazard and frequently require metallurgical, technical, and practical compromise with the design limitations imposed. The author went on to discuss experiments conducted over a number of years to solve the problems of contraction and distortion in large castings such as machine tool beds, tables, slides, trays, etc.

In an effort to reduce camber allowances, Mr. Longden developed a system of air cooling the ways of roll grinding machine beds by casting pipes in them. Tests on a boring bar 47 ft long were described, as well as tests on a machine bed over 41 ft long. To develop fundamental information, a number of test castings were designed and made to provide information on influence of contrasting depths and sections on contraction and distortion.

Mr. Longden concluded his paper with a graph which can be used to determine the camber required for a casting of any given length, depth and wall thickness. A comparison of contraction in cast steel and cast iron was also given.

The two sessions the afternoon of May 6 constituted a symposium on heat treatment of gray cast iron. G. A. Timmons, Climax Molybdenum Co., commented on the symposium, and was followed by A. Boyles, U. S. Pipe & Foundry Co., who spoke on *"Fundamentals of Heat Treating Gray Cast Iron."* In a paper which appeared in the May issue of AMERICAN FOUNDRYMAN, pages 97-106, Mr. Boyles reviewed some of the fundamental principles involved in the heat treatment of cast iron. Pointing out that equilibrium conditions in cast iron are more complex than in steel and not so well known, he compared behavior on heating and cooling of a plain carbon pearlitic steel of eutectoid composition with a plain cast iron having a pearlitic matrix.

*Past President S. V. Wood presenting certificate of Honorary Life Membership to President Max Kuniansky.*



### Explains Iron-Carbon Alloy Stability

Mr. Boyles brought out the difference between the stable and the metastable state in iron-carbon alloys, explaining that the former involves iron and graphite whereas the latter involves iron and iron carbide. He then described the changes in microstructure which occur according to the two states when plain cast iron is heated and cooled. The author elaborated on the dual behavior of cast iron by showing that transforma-

tion can occur according to both the stable and metastable states at the same time in the same material.

R. A. Flinn presented the paper *"Gray Iron Hardenability and Its Relation to Air Quenching of Castings"* by Flinn and R. J. Ely, both of American Brake Shoe Co. From a study of the range of hardenability available in unalloyed and nickel-molybdenum gray iron, and the use of these values in planning quenching of castings, the authors concluded: (1) properly controlled gray irons have both reproducible hardenability and a wide range of hardenability similar to alloy steels; (2) hardenability may be adjusted by use of alloys to provide compositions that will harden by air cooling from 1600 F, thereby reducing cracking and distortion; (3) the alloyed compositions may also be used for differential hardening by induction or flame heating followed by air cooling.

Presiding were J. S. Vanick, International Nickel Co., and T. E. Eagan, Cooper-Bessemer Corp.

*"Stress Relief of Gray Iron Castings,"* by J. H. Schaum, Naval Research Laboratory, and *"Conventional vs. Salt Bath Hardening of Cast Iron Cylinder Liners,"* by G. Lahr, General Motors Corp., completed the symposium. H. Bornstein, Deere & Co., presided at the session; co-chairman was D. A. Paull, Sealed Power Corp. Mr. Schaum's paper will appear in a future issue of AMERICAN FOUNDRYMAN.

### Recommends Salt-Bath Treatments

In a paper taken from his General Motors Institute thesis, Mr. Lahr explained that conventional methods of cylinder liner heat treatment present shop problems in distortion, growth, scaling, and cracking. He described the oil quenching procedure and two salt bath treatments, and listed as the advantages of the latter: (1) absence of scale eliminates need for grit blasting; (2) elimination of arbor removes cause of contraction cracks; (3) distortion is minimized, thus reducing precision grinding difficulties; (4) by increasing the internal diameter size prior to heat treatment in accordance with the growth data obtained in these tests, the machining operations following heat treatment can be minimized; (5) the time required for hardening is reduced considerably.

At the Friday, 10:00 a.m. session over 300 foundrymen and metallurgists heard H. Morrogh, British Cast Iron Research Association, present *"The Production of Nodular Graphite Structure in Gray Cast Iron,"* and W. W. Austin, Jr., Southern Research Institute, discuss *"Improvement of Machinability in High Phosphorous Gray Cast Irons."* J. T. MacKenzie, American Cast Iron Pipe Co., presided and W. W. Levi, Lynchburg Foundry Co., was co-chairman.

*Rear Admiral Homer N. Wallin, Commander, Philadelphia Naval Shipyard, showing samples of Navy foundry work exhibited at the 52nd Annual Foundry Congress to National Director John M. Robb, Jr.*

Presenting his paper first, Mr. Austin described three methods of attack on the problem of improving the machinability of high phosphorus gray irons: (1) modification of the mode of occurrence of the phosphide constituent; (2) control of the microstructure exclusive of the phosphide constituent; (3) removal of constituents known to affect machinability adversely. The latter included desulphurization and dephosphorization treatments of the molten metal, and combinations of these treatments with alloy additions.

In a written discussion prepared by Hans Ernst, and read by Martin Rollman, both of Cincinnati Milling Machine Co., the value of the drill penetration test for determining machinability was questioned and a turning test suggested. It was also pointed out that

*An estimated 15,000 people passed through the entrance of Convention Hall to see exhibits and attend meetings.*

*Ladies entertainment started with a reception, tea, and fashion show in the auditorium of John Wanamaker's store, and included visits to Valley Forge and other historic sites throughout the Philadelphia area.*

micro-hardness tests of steadite were reported for room temperature whereas temperatures at the contact between cutting tool and work are of the order of 900 F at which temperature the hardness of steadite might be expected to be considerably lower.

Francis W. Boulger, Battelle Memorial Institute, emphasized Mr. Austin's point that it is not necessary to change the phosphorous content of an iron to improve its machinability, and suggested that the desulphurization and zirconium treatments described should be worthwhile because they are inexpensive.

H. Morrogh's paper describing the production of cast irons with nodular graphite in the as cast condition, thus eliminating lengthy heat treatment, was hailed as an important contribution to the fundamental knowledge of metallurgy. Discussors of the paper included many of the foremost gray iron metallurgists of the United States and Canada. The method involves the treatment of a low sulphur hypereutectic cast iron with cerium shortly before casting. The cerium functions as a desulphurizer and as a carbide stabilizer. To achieve completely nodular graphite the treatment with cerium is followed with a graphitizing inoculant.

Mr. Morrogh's paper appeared in the April issue of AMERICAN FOUNDRYMAN, pages 91-106.

### Oxygen-Enriched Cupola Blasts Discussed

R. G. McElwee, Vanadium Corp. of America and E. C. Jeter, Ford Motor Co., were chairman and co-chairman, respectively, of the sixth gray iron session, Friday afternoon. Discussion of the first paper, *"Oxygen Enriched Cupola Blast,"* by W. C. Wick, Armour Research Foundation, was so prolonged that two written discussions were not presented in order to allow sufficient time for the second paper, *"Solidification Characteristics of Gray Iron,"* by J. H. Schaum, Naval Research Laboratory, and J. E. Fifield, International Nickel Co.

Mr. Wick's paper (see pages 64-74, May issue, AMERICAN FOUNDRYMAN) described success of oxygen-enriched cupola blasts in increasing melting rates and tapping temperatures. Savings in coke with no sacrifice in operating conditions, and elimination of bridging and of cold metal, were explained.

The work reported by Messrs. Fifield and Schaum involved bleeding of partially solidified gray iron castings and temperature measurements in identical castings poured simultaneously. The authors concluded that: (1) the rate of solidification of gray iron in a given section size varies inversely with the temperature above solidification temperature at which the metal is poured; (2) the rate of solidification increases with decrease in cross sectional area; (3) the rate of solidification varies with composition; (4) cast iron acts essentially as a solid after it cools to slightly below the liquidus, the tightly interlaced dendrites being able to hold their shape and support a considerable weight of liquid metal; (5) blind risers do not function in cast iron because of weak skin strength.

## HEAT TRANSFER

The heat transfer session was held the afternoon of May 4 with E. C. Troy, National Engineering Co., presiding and H. F. Taylor, Massachusetts Institute of Technology as co-chairman. In the absence of Heat Transfer Committee Chairman H. A. Schwartz, National Malleable & Steel Castings Co., Mr. Troy read the committee report which indicated that the 1947 activities of the committee had consisted essentially of elaborating work reported in 1946. Whereas the work done at Columbia University with the heat and mass flow analyzer confirms the work of Briggs and Gezelius it does not confirm the conclusion of Chvorinov that the freezing time of a body could be determined as a function of the ratio of its surface area to its volume.

Dr. Victor Paschkis, technical director of the heat and mass flow analyzer laboratory, Columbia University, reported his recent work in three papers: *"Studies on the Solidification of Aluminum Castings"; "Studies on Solidification of White Iron Castings"; and "Study on Solidification of Steel Spheres."* The first paper covered a comparison between bleeding tests of pure aluminum castings and the electrical analogy method.

*Some of the leaders in the patternmaking field sat at the head table at the Pattern Round Table Luncheon which was attended by 122 interested patternmakers.*

The work on white iron was done to confirm the suitability of the electrical analogy method of studying solidfication of metals to materials on which thermal properties were less well known than for steel. Dr. Paschkis' second paper showed that tests made on the electric analyzer check reasonably well with bleeding tests carried out on white iron by Dr. Schwartz in previous years.

Working with the original data developed by Briggs and Gezelius, and supplied by C. W. Briggs, Steel Founders' Society of America, Dr. Paschkis confirmed this early work and showed that the electrical analogy method was valid for spheres. Heretofore the electrical analogy method has been used to study slabs so big that the end effect could be neglected. The research showed that freezing rate is not alone a function of surface area to volume ratio, as stated by Chvorinov, but that the degree of superheat is a governing factor.

## FOUNDRY COSTS

Answers to puzzling foundry cost problems were given to members of an audience numbering over 150 at the question-and-answer session sponsored by the Foundry Cost Committee. Held Thursday afternoon, May 6, with R. L. Lee, Grede Foundries, Inc., presiding, the session consisted of answers to questions submitted in writing prior to the meeting and also those asked from the floor. C. E. Westover, Westover Engineers, co-chairman of the meeting, and C. S. Roberts, Dodge Steel Co., comprised the panel of cost experts, along with Mr. Lee.

## BRASS AND BRONZE

Opening at noon of the first day of the Convention with a Brass and Bronze Round Table Luncheon, the Division's program included three technical sessions and an Annual Lecture Course meeting.

H. L. Smith of the Federated Metals Division, American Smelting and Refining Co., spoke at the Round Table Luncheon. In his talk, Mr. Smith outlined *"Recent Developments in the Melting of Brass and Bronze,"* in which he pointed out the effects of gases on molten metal. B. A. Miller, Baldwin Locomotive Works, presided at the luncheon, and R. J. Keeley acted as co-chairman.

*Chapter boundaries were not recognized at the Chapter Officers and Directors Dinner the evening of May 4 when representatives of A.F.A.'s 44 chapters met.*

*Service for exhibitors was readily available through the offices adjacent to A.F.A. Convention Headquarters.*

At the first of the Brass and Bronze Technical Sessions, V. A. Simpson presented *"An Approach to Quality Control in Castings Production,"* a paper written in conjunction with G. K. Eggleston. Both the authors are from the Barnes Manufacturing Co.

Mr. Simpson discussed a method of controlling quality of products manufactured in the Barnes plant, which he defined as "the necessary inspections or process controls to produce a product to predetermined chemical, physical, dimensional and visual standards, at the lowest cost consistent with the standards set."

He stated that he had found that the most logical man to be held responsible for quality control is the chief engineer, but that the actual work along that line should be done primarily by the assistant chief engineer. However, Mr. Simpson added, the quality control man has absolutely no jurisdiction over production personnel. Production supervisors should be free to make any changes that they feel will reduce costs, but the change must be submitted to the quality control man in writing. On the other hand, he said, quality control has absolute authority over the quality of work produced and can detect and reject castings, and stop production when there are too many rejects.

*"Ingot Metal vs. Virgin Metal"* was presented as the second paper of the May 3 technical session by William Romanoff, H. Kramer & Co., in the absence of F. L. Wolf, author of the paper.

According to Mr. Wolf, ingot metal offers many advantages over the use of virgin metal, i.e., saving in storage room, in time consumed making up charges, in preparation for weighing, and in alloying time.

Conclusions drawn by Mr. Wolf from his experiments included: melting loss is about the same on ingot and virgin metals; foundry and bench losses are lower on ingot metal; ingot metal castings have a better appearance after chemical treatment; fractures of test plugs made from ingot metal are superior to those made from virgin metal.

H. M. St. John, Crane Co., presided at the session, with J. J. Curran, Walworth Co., as co-chairman.

More than 125 foundrymen attended the May 4 morning session of the Brass and Bronze Division to hear the Institute of Australian Foundrymen's Exchange Paper and a talk by Colonel A. I. Krynitsky

*Foundrymen swarmed through the exhibit halls seeking new ideas in foundry practice, new equipment, new materials and supplies, and old acquaintances.*

of the National Bureau of Standards, Washington, D.C.

William Ball, Jr., Magnus Brass Division, National Lead Co., presented the Australian Exchange Paper, *"The Technology of Copper-Lead Alloys"* for Author R. W. W. Honeycombe, Melbourne, Australia.

### Australian Exchange Paper

Limiting his paper to a discussion of alloys of copper containing from 10 to 40 per cent lead, Mr. Honeycombe stated that many of the difficulties of casting such alloys would be eliminated if there were a clearer understanding of the Hansen Copper-Lead equilibrium diagram. The paper went on to discuss the binary alloys of copper and lead, their tin content and casting temperatures; the effect on physical properties of alloying elements; friction and wear; and applications.

Discussion of Mr. Honeycombe's paper brought out the fact that Australian practice in casting leaded bronzes is substantially the same as American-Canadian procedures. The relative effects of tin, nickel and sulphur, of dissolved gases and of cooling rate on the distribution of lead in the bronze was of considerable interest, in view of the animated discussion of these points. It was agreed that small additions of sulphur were desirable because of the surface tension effects of sulphur on copper dendrite growth.

Following discussion of Mr. Honeycombe's paper, A. I. Krynitsky presented a paper written in collaboration with W. P. Saunders and H. Stern, National Bureau of Standards, on *"The Effect of Foundry Practice on Some Binary Copper-Silicon Alloys."*

Col. Krynitsky spoke on the tensile properties of four types of copper-silicon alloys containing from 2.0 to 4.9 per cent of silicon. An increase in tensile strength and a decrease in elongation of the test bars is possibly due to an increase in the amount of precipitated constituents in the microstructure of these alloys, he said, adding that the optimum tensile properties were obtained from Navy 10B type of test bar.

Lower tensile properties, density and indentation hardness were found in 4.9 silicon alloy castings made under hydrogen and carbon monoxide, than in those under air, helium, carbon dioxide and nitrogen, he stated. The principal cause of unsound castings revealed by hydraulic pressure tests, Col. Krynitsky concluded, was interconnected shrinkage cavities caused by inadequate feeding.

During the discussion of Col. Krynitsky's paper, the question was raised as to why the bronzes mentioned are so suitable for pressure-tight castings and yet are so subject to the influence of gases when melted under the wrong atmosphere. In reply, it was stated that leakers are caused by shrinkage and that the problem could be readily solved by proper feeding. Prof. R. M. Brick of the University of Pennsylvania presided at the session, with C. A. Robeck, Gibson & Kirk Co., acting as co-chairman.

Kurt A. Miericke led off the May 4 afternoon discussion with a paper on *"A New Permeable Metal Casting Plaster,"* written in collaboration with E. S. Johnson. Both men are from U. S. Gypsum Co.

Mr. Miericke spoke on the development of a new type of highly permeable gypsum metal casting plaster, which, he said, can produce any desired degree of permeability and eliminates the need for complete dehydration of molds. The plaster makes lower "burnout" temperatures possible, he added, and has good mold strength. He cited greater operational flexibility and savings in time and fuel as additional advantages of the new plaster.

In a written discussion on Mr. Miericke's paper, A. K. Higgins, Allis-Chalmers Manufacturing Co., supplemented the author's claims and stated that his company has tried the new plaster, using infra-red heating, and has found that it dried within 10 minutes or less. He thanked the authors for a notable contribution to the foundry industry.

Speaking on *"The Value of Pressure Tests and Radiographs of Gun Metal Castings,"* W. H. Baer, Naval Research Laboratory, stated that he had concluded as

*The Aluminum and Magnesium Round Table Luncheon featured a talk on a permanent mold for aluminum test bars and a discussion of permanent mold casting.*

*The Engineering School Graduates Luncheon attracts educators and graduates from many technical schools.*

the result of recent investigations that gun metal castings showing light shrinkage in a radiograph are of questionable acceptability; that radiographs showing a medium shrinkage or gas porosity in combination with shrinkage indicate a serious condition and greater possibility of leakage under pressure.

Further conclusions drawn by Mr. Baer included: concentrated shrinkages or tears are the most dangerous types of discontinuities and are sufficient cause for rejecting castings, castings intended for critical use should be radiographed as well as pressure tested. R. W. Parsons, Ohio Brass Co., was chairman and A. K. Higgins, Allis-Chalmers Mfg. Co., co-chairman.

Speaker for the Annual Lecture Course session, held the afternoon of May 4, was William Romanoff, H. Kramer & Co., who spoke on *"Test Procedures for Quality Control of Sand Castings—Brass, Bronze and Nickel Alloys."* An interesting sidelight on the subject was brought out during the discussion following Mr. Romanoff's address, when a show of hands was requested of those using the fracture test. Less than a dozen of the 125 present indicated that they used it.

## ALUMINUM AND MAGNESIUM

Scheduled during the first two days of the Convention, May 3 and 4, three technical sessions, an Annual Lecture Course meeting, and a round table luncheon comprised the Aluminum and Magnesium program.

H. E. Elliott, Dow Chemical Co., opened the first technical session on the morning of May 3 with a paper on the *"Effect of Gating Design on Metal Flow Conditions in the Casting of Magnesium Alloys,"* written with J. G. Mezoff, Saginaw Bay Industries, Inc.

Mr. Elliott stated that improper sprue design may lead to casting defects by the entrainment of gases in the metal stream and that gating turbulence can exaggerate skins, blows, and microporosity of castings. He cited skim-gates as a valuable method for controlling gating turbulence.

### Discusses Pouring Factors

Mr. Elliott remained on the speaker's platform to present the second paper of the session, *"A Study of Factors Affecting Pouring Rates of Castings,"* also written in collaboration with Mr. Mezoff. Using magnesium alloys to conduct tests, the authors found that the effects on pouring rate of the following design factors were established: sprue cross-sectional area, sprue cross-sectional shape, sprue length, sprue taper, sprue mouth design and pouring basin depth. Mr. Elliott also reported the effects of pouring temperature.

Speaking on *"Step Aging of a Magnesium Base Casting Alloy,"* E. J. Vargo, Wellman Bronze and Aluminum Co., co-author of the paper with G. Sachs, Case Institute of Technology, stated that long-time, low-temperature aging of magnesium casting alloy AZ63 produced a better combination of properties than were obtained with a short-time high-temperature aging treatment, particularly higher tensile strength and greater elongation without loss in yield strength.

Mr. Vargo added that the authors attributed the superior physical properties obtained with low temperature aging to reduced size and spacing of the lamellar precipitate. Step aging, he added, results in a microstructure similar to that obtained in a much longer time at a temperature between those of the step aging

*F. J. Walls' (center) gray iron control lecture will appear in book form with the other 1948 lectures.*

*E. C. Troy (speaking) and Professor H. F. Taylor presided at the May 4 session on heat transfer research.*

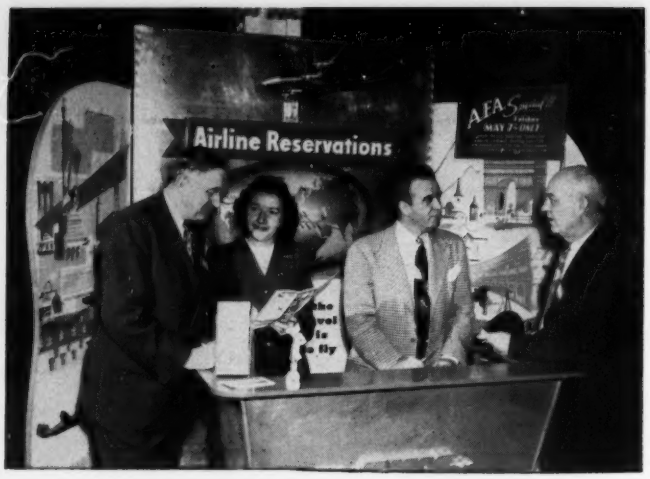
operations. L. Brown, Bohn Aluminum and Brass Corp., and A. T. Ruppe, Bendix Aviation Corp., were co-chairmen of the session.

More than 200 foundrymen attended the afternoon technical session to hear papers presented by F. G. Tatnall, Baldwin Locomotive Works, and T. R. Gauthier, Aluminum Company of America.

Mr. Tatnall, speaking on *"Can Castings Be Engineered?"*, described thin wire gauges and strain gauge technique for analyzing strain in metal components, and explained brittle lacquer technique for stress analysis in components to indicate location of points weak in design.

An unscheduled paper, *"Engineering for Aluminum Alloy Castings,"* written by T. R. Gauthier and H. J.

*The American Foundrymen's Association booth illustrated Association services and world-wide activities.*




*An airline official reported air traffic in Philadelphia reached a new high during the A.F.A. Convention.*

Rowe, of the Aluminum Company of America, was presented by Mr. Gauthier. According to the authors, the properties and characteristics of aluminum alloys account for the use of aluminum castings for many applications, but in other cases the many commercial processes by which such alloys can be cast provide important economic advantages.

In order to utilize these advantages to the maximum, Mr. Gauthier stated, basic casting design limitations and the merits of each casting method must be taken into consideration during the early stages of casting design. He stressed the need for close cooperation between the design engineer and the producing foundry. C. E. Nelson, Dow Chemical Co., and M. H. Young, Wright Aeronautical Corp., presided at the session.

### Outlines Quality Control Procedure

E. V. Blackmun, Aluminum Company of America, presented the Annual Lecture Course paper on aluminum and magnesium on Monday afternoon—*"Test Procedures for Quality Control of Aluminum and Magnesium Castings"*—in which he stressed the need for checking raw materials for quality and uniformity and adherence to specifications. He also emphasized the importance of controlling and supervising processes. M. E. Brooks, Dow Chemical Co., presided at the Lecture, and D. Basch, Aluminum Company of America, served as co-chairman.

At the May 4 morning session, attended by approximately 200 foundrymen and visitors, L. W. Eastwood, Battelle Memorial Institute, co-author with the late L. W. Kempf, Aluminum Company of America, spoke on *"Aluminum–Zinc–Magnesium–Copper Casting Alloys,"* in which he outlined the tensile properties and hardness of such alloys containing 0.25 per cent chromium and 0.15 per cent titanium, investigated over a range of 0 to 1.75 per cent copper, 3 to 13 per cent zinc, and 0 to 1.0 per cent magnesium.

This alloy, Mr. Eastwood stated, ages at room temperature without any previous heat treatment and attains high tensile properties, endurance limit, resistance to failure by impact, and good resistance to corrosion in the accelerated tests made by the authors.

Speaking on the *"Effect of Titanium on Grain Size and Tensile Properties of an Aluminum–4.5 Per Cent Copper (No. 195) Casting Alloy,"* R. C. Boehm presented his Master's thesis submitted to Case Institute of Technology, co-authored by W. E. Sicha, Aluminum Company of America.

Mr. Boehm stated that grain refinement obtained by the addition of titanium to No. 195 aluminum alloy was influenced by particles of $TiAl_3$ which were reduced in size in passing through the peritectic range.

The tensile properties obtained with variations in titanium were the resultant of four factors: the beneficial effect of the grain refinement; the deleterious influence of the $TiAl_3$ particles; the slight coarsening and concentration of insoluble constituents at the grain boundaries; and the effect of retarded artificial aging proportionate to the amount of titanium added.

A paper by the same authors, *"A Fluidity Test for Aluminum Casting Alloys,"* presented by Mr. Sicha, outlined a standard procedure for measuring the relative fluidity or mold filling capacity of aluminum alloys on different lots of the same aluminum alloy. The author's information supplements that published in 1939 by L. W. Eastwood and L. W. Kempf. H. Brown, Solar Aircraft Co., was chairman of the session, and H. R. Youngkrantz, Apex Smelting Co., co-chairman.

Speaking at the Aluminum and Magnesium Round Table Luncheon, L. J. Ebert, co-author with R. E. Spear and G. Sachs, all of the Case Institute of Technology, presented *"The Development of a Permanent Mold for Aluminum Tensile Test Bars."*

Mr. Ebert described a permanent mold developed for the casting of aluminum alloy test bars with a short-time operating cycle, utilizing a two-bar mold cavity so designed that castings can be obtained with the pouring of only a small amount of metal and with a minimum of trimming to remove gates and risers.

Five different aluminum alloys were cast to determine the factors influencing mold operation and test bar properties. Pouring temperature affected the mold operating cycle only slightly, but the mold temperature had a great effect upon the cycle and influenced the tensile and hardness properties. Heat treated alloys, Mr. Ebert added, were especially responsive to mold temperature change. The thickness of the mold coat, time of casting in the mold, and rate of pouring affected the tensile properties only under extreme conditions.

*The A.F.A. Apprentice Contest display, as always, stimulated interest and discussion among foundry experts.*

# VOTE TO RENAME ASSOCIATION AMERICAN FOUNDRYMEN'S SOCIETY

## *By-Laws Amended By Letter Ballot of Membership*

CHANGING THE NAME in accordance with the wishes of an overwhelming majority of the membership, the American Foundrymen's Association becomes the American Foundrymen's Society on July 1. The name change and other amendments to the By-Laws were proposed to the membership which voted by letter ballot to adopt all the revisions suggested by the By-Laws Committee.

American Foundrymen's Society is a name more descriptive of the functions of the organization and conforms to the names of other technical societies. The object of the Society has been restated for simplification: *"to advance the arts and sciences relating to the manufacture and utilization of metal castings."*

The newly-adopted revisions were suggested for clarification, to make the By-Laws conform to current organization practice, or to make more definite provision for carrying on Society affairs.

Membership classifications are defined in the amended By-Laws which state in part (Article II, Section 1, (c) : *"No Company or Sustaining membership will qualify individuals for Personal membership at minimum annual dues, where such individuals reside outside the territory of the Chapter in which such Company or Sustaining membership is held."*

The Article entitled Chapters provides that *"no member of the Society shall be recorded as holding membership in more than one Chapter."* It further provides: *"only Members of the Society in good standing shall be eligible to hold office in any Chapter."* Other changes affecting Chapters require that each Chapter shall be governed by a set of by-laws which has been approved by the Society's Board of Directors and adopted by the Chapter membership.

Technical publications over the name of the Society may not be issued or distributed by any Chapter without the approval of the Publication Committee of the Society. This does not affect presentation of papers at chapter meetings or regional conference, nor distribution of such papers to Chapters or the membership.

*"The Chapters shall submit not later than July 15 to the Treasurer of the Society an annual financial report"* according to Article XVII, Section 10, which adds *"this report shall be in accordance with the requirements of the Manual for the Conduct of Chapters."*

Research activities, long a major function of the organization, gained added impetus through a new Article which makes definite provision for research activities. The Board of Directors may authorize research on problems of value to the castings industry and may make provisions for financing these activities.

A change in the Board of Awards provides that the Chairman shall be the Senior Past President of the last seven living Past Presidents, who comprise the Board, instead of the Junior Past President.

Future By-Laws amendments will be made by letter ballot sent to all Society members *"in good standing in the United States, Canada, and Mexico,"* the latter having been added in the latest revision.

General revision of the By-Laws was approved by the Board of Directors acting on the recommendation of the By-Laws Committee headed by Past President H. Bornstein, Deere and Co., Moline, Ill. Other members of the committee were: President-Elect W. B. Wallis; Past-President L. C. Wilson, Reading, Pa.; Director-Elect N. J. Dunbeck, Eastern Clay Products, Inc., Jackson, Ohio; F. W. Shipley, Caterpillar Tractor Co., Peoria, Ill.; J. A. Wotherspoon, J. A. Wotherspoon & Son, Ltd., Oakville, Ont., Canada; and D. C. Zuege, Sivyer Steel Casting Co., Milwaukee.

Tellers appointed by National President Max Kuniansky were: R. W. Schroeder, University of Illinois, Chicago; James Thomson, Continental Foundry & Machine Co., East Chicago, Ind.; and A. S. Klopf, Western Foundry Co., Chicago. The tellers met at the National Office in Chicago, May 15, to count the letter ballots for the amendments to the By-Laws.

## Hold Chapter Chairmen Conference To Discuss Association Problems

FOR THE FIRST TIME, both incoming chapter chairmen and vice-chairmen have been invited to attend the Annual A.F.A. Chapter Chairmen Conference, to be held at the Stevens hotel, Chicago, June 28-30.

Topics to be discussed at the Conference will include chapter administration and its attendant problems, A.F.A. budgeting and financing, technical programs for the coming year, foundry educational programs, and the development of plans for AMERICAN FOUNDRYMAN and other A.F.A. publications.

National Vice-President Elect Edwin W. Horlebein will preside at the Conference. Chairman and vice-chairman from the Association's 39 chapters, National Officers and Directors, will attend.

The purpose in extending invitations to chapter vice-chairmen this year is to give them the benefit of an additional year of training in administration, in preparation for the time when they will take over the chairmanship of their respective chapters.

## Technical Correlation Committee Holds Meeting In Chicago June 18

THE ANNUAL MEETING of the A.F.A. Technical Correlation Committee will be held at the LaSalle hotel, Chicago, June 18.

Chairmen of A.F.A. technical divisions and general interest committees will report on the activities of their respective groups. Technical programs, policies, and research projects for the coming year will be discussed.

Past National President Sheldon V. Wood, Chairman of the Technical Correlation Committee, and S. C. Massari, A.F.A. Technical Director, will preside at the Committee Meeting.

# BLAST VARIATIONS SERIOUSLY AFFECT CUPOLA OPERATIONS

**B. P. Mulcahy**
**Consultant**
**Indianapolis, Ind.**

UNQUESTIONABLY, air is the most important material entering into cupola operation. When improperly used in any respect it can affect the chemistry or the mechanics of the process in many disastrous ways.

The one element over which the cupola operator, if he would, could have complete control is the air. By proper design of the conducting system, selection of the proper blower and, finally, the admission and control of the proper quantities, the operator can establish a fully reliable process for introducing the air. Such a system would be completely independent of the human vagaries which are so much a part of all other factors of cupola operation.

Air is the one material entering the cupola which is never seen. It is also the least expensive of the commodities used. It is elusive because of its extreme fluidity, and it is confined only by the sides of the vessel containing it. It is this elusiveness which has created the universal difficulty attached to its proper measurement and control.

Production rates, costs, losses, coke ratios, metal temperature, analyses and physical properties are influenced by air. Because of its influence, operators should be thoroughly conversant with its habits so that they may control its influence in the manner desired.

It is, of course, the oxygen in the air with which cupola operators are concerned, both in its elemental effect and its reaction activity in the combustion of the coke to the carbon gases. The reactions and results are multiple, which accounts for the wide disparity in operations encountered, but the reactions proceed according to definite laws and are subject to control.

The purpose of this discussion is to survey the individual parts of the air system, to investigate the conditions responsible for its many diverse effects and, finally, to identify the principal factors governing the process in order that the operator may properly direct and control the air to obtain the greatest benefits.

In general, this discussion will be confined to cold blast operation, with only a brief mention of the special processes of hot blast and dehumidification. Only fundamentals are considered, and these are not materially altered by the use of special equipment.

## I—Air System

The quantity of air used in the cupola for each day's heat is far greater than is generally realized. Depending upon the particular conditions of combustion existing, the amount of air by weight will be equal to or greater than the amount of metal charged. This is shown graphically in Fig. 1, where for a 100-ton heat it is shown that the amount of air required is 105 tons. It is larger in amount than any of the other materials charged. This fact alone should convince the operator that the accuracy of its measurement should at least be equal to that of the metal charged. A second important point on this figure is the proportion between the quantity of air charged and the amount of coke used. Each ton of coke requires approximately 8 tons of air; in the instance given, bed coke has been figured in the total quantity.

Because of the wide disparity in amounts between coke and air, it might be felt that the quantity of air could vary widely without injurious results. It can

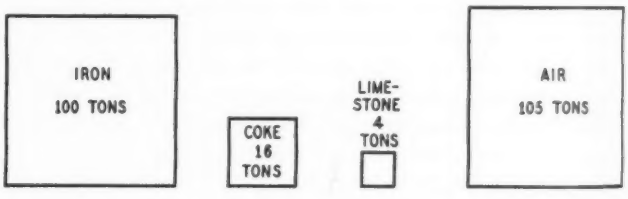



*Fig. 1—Weight of materials charged for 100-ton heat.*

and does vary widely but, as will be pointed out, with every shift in the ratio of air to coke there is a shift in combustion conditions, with its corresponding effect on operation.

The objective of the air system is to introduce the correct amount of air at all times into the cupola. Since this is a mechanical system the operator must, therefore, consider all of the elements of the system and their respective influence on the objective.

Figure 2 will illustrate the essential parts of the air system. This has been broken down into: *A*—blower; *B*—wind line; *C*—meter; *D*—wind box; *E*—tuyeres.

*A—Blower:* The blower, of course, is the source of the air required. The types generally used are the rotary or positive pressure, the fan and turbine. Actually, the type used is immaterial if it will deliver the quantity of air required, and mechanically possess a reasonable life expectancy. The important point regarding the blower is that it shall have sufficient capacity for variable demands for the cupola to which it is connected, and that its volume can be changed properly within the range of melting rates desired. The blower must be maintained in good condition.

Frequently the blower may be designed for sufficient capacity but the motor may be too small to carry a higher load. In this case the motor may be the limiting factor in obtaining the quantity of air required.

*B—Wind Line:* This should be of sufficient size to conduct the air generated at the blower to the wind box with a minimum of pressure loss. If an orifice-type meter is employed, the wind line should have sufficient length of straight run to permit proper installation of the orifice. This is an important point and seldom given the consideration it deserves.

One of the common faults of the air system is the improper location of the blower, requiring a tortuous wind line to make the connection to the cupola. The wind line should be free from leaks and of sufficiently heavy material properly mounted to resist vibration.

*C—Meter:* A reliable meter is a "must" for all cupola operations. There are two general types, the orifice or pitot tube, operating on the principle of pressure differential, and the ammeter, measuring power input. In either case the function of the meter is to give a reliable index of the rate of flow of air at some standard condition. Generally, this is 60 F, 30 in. Hg. The pitot tube type is frequently used as an indicating meter, but the rate must be constantly adjusted by hand to maintain a predetermined volume. This is not too satisfactory, requiring constant surveillance by the operator to correct for changing conditions. Installation of this type is difficult if reliable readings are to be obtained.

The desirable arrangement, of course, is to control the blower delivery by some positive regulator for a predetermined air rate, this rate being maintained until it is again deliberately reset.

### Install Meter Properly

A good meter can be improperly installed and extreme care should be exercised that the meter is registering the correct amount of air. Many operators are content if the meter shows relative changes. This is not sufficient because the chief concern is with maximum economy, in which fundamental laws govern, and the instruments, therefore, should measure the correct quantity of all materials used.

A pressure gauge is a valuable and simple instrument which should be attached to each cupola. However, it is not a substitute for a meter. The pressure gauge will measure a state of pressure in the entire system.

With other conditions remaining the same, a change in air rate will be reflected by a change in the pressure in a regular proportion. However, with the air rate remaining the same (when automatically controlled), and an increase in resistance to flow builds up in the cupola due to "bridging" or stock size or other cause, the pressure will increase, which will illustrate the danger attached to using the pressuge gauge as an index of rate of flow under all conditions. The pressure existing in any cupola is dependent on the amount of air flowing, the tuyere size, and the back pressure condition within the stack.

*D—Wind Box:* The intent of the wind box is to provide a chamber from which the air can be uniformly distributed to each tuyere. Actually, such a state seldom exists, becaues the wind box does not have sufficient capacity and is not properly designed to accomplish this. With a single entry tangent wind line a circular flow of air is set up, and potentially the amount

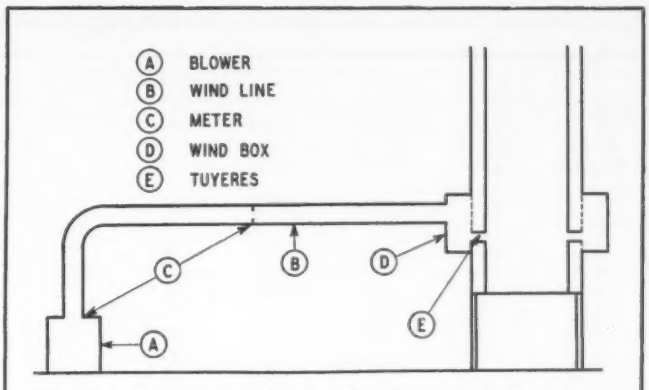



*Fig. 2—Diagrammatic sketch of cupola air system.*

of air flowing through each tuyere can be different. In most instances, the highest rate of flow will be through the tuyeres located 180° from the wind line entry. With a double wind line the highest rate of flow is generally through the tuyeres located midway between both wind line entries.

The wind box should be tight in all respects. Because the wind box does not function as it should, the objective of an equal quantity of air through each tuyere is seldom accomplished and corrections toward this end must be made. This will be discussed later.

*E—Tuyeres:* No attempt will be made in discussing this factor to include all of the ideas which have been developed over the years. The function of the tuyeres is simply to permit equal quantities of air to pass through each tuyere continuously during the heat. The simplest design which will accomplish this purpose is the best.

Continuous vs. intermittent tuyeres has always been a subject of considerable dispute. Actually, most of the dispute arises from the fact that, in many instances, the word "continuous" is a misnomer, and further, when a cupola is "bridging" badly, any difference existing initially between the two types of tuyeres has been completely destroyed.

The writer prefers the simple conventional box-type tuyere because they are easily constructed and permit easy modification of area for controlling the flow. For cupolas up to 60 in. in diameter, a good total area (measured wind box side) has been found to be approximately 25 per cent. For cupolas larger in diameter than 60 in. the total area should be from 15 to 25 per cent.

With the foregoing areas, sufficient surplus area is available to reduce one or more tuyeres to effect proper air distribution. This is easily done by mudding-in bricks to correct the flow of air, as dictated by repeated cupola burn-outs. The tuyeres should be kept in good mechanical condition, that is, warped or broken pieces should be immediately removed in order to support the lining and to maintain the proper area.

### II—Function of Air

It is understood, of course, that the principal function of air is to furnish oxygen for the combustion of coke to supply the heat required for melting the iron. There are several secondary conditions which should not be overlooked, namely, the potential combustion of the carbon, silicon and manganese in the metal,

TABLE 1—AIR REQUIRED FOR DIFFERENT COMBUSTION CONDITIONS

| Carbon Combustion | | | | | | | | | Coke Combustion (90% Carbon) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| lb $O_2$ per lb Carbon | lb Air per lb Carbon | cu ft Air per lb Carbon | Gas Analysis, % volume | | | Ratio $CO_2$/CO | | Heat Released per lb. Carbon, Btu | lb Air per lb Coke | cu ft Air per lb Coke | Heat Released per lb Coke |
| | | | $CO_2$ | CO | $N_2$ | $CO_2$ | CO | | | | |
| 2.66 | 11.5 | 151 | 21.0 | 0.0 | 79.0 | 100 | 0 | 14550 | 10.3 | 136 | 13100 |
| 2.53 | 10.9 | 143 | 19.7 | 2.1 | 78.3 | 90 | 10 | 13530 | 9.8 | 129 | 12200 |
| 2.39 | 10.4 | 136 | 18.3 | 4.5 | 77.2 | 80 | 20 | 12510 | 9.4 | 123 | 11250 |
| 2.26 | 9.8 | 128 | 16.6 | 7.1 | 76.3 | 70 | 30 | 11490 | 8.8 | 115 | 10350 |
| 2.13 | 9.2 | 121 | 15.0 | 9.9 | 75.1 | 60 | 40 | 10470 | 8.3 | 109 | 9400 |
| 2.00 | 8.7 | 113 | 13.0 | 13.0 | 74.0 | 50 | 50 | 9450 | 7.8 | 102 | 8500 |
| 1.86 | 8.1 | 106 | 10.9 | 16.6 | 72.5 | 40 | 60 | 8450 | 7.3 | 95 | 7600 |
| 1.73 | 7.5 | 98 | 8.7 | 20.3 | 71.0 | 30 | 70 | 7410 | 6.8 | 88 | 6700 |
| 1.60 | 6.9 | 91 | 6.1 | 24.6 | 69.3 | 20 | 80 | 6390 | 6.2 | 82 | 5750 |
| 1.46 | 6.3 | 83 | 3.2 | 29.4 | 67.4 | 10 | 90 | 5370 | 5.7 | 75 | 4800 |
| 1.33 | 5.8 | 76 | 0.0 | 34.7 | 65.3 | 0 | 100 | 4350 | 5.2 | 68 | 3900 |

*Air (cu ft) at 60 F, 14.7 psi pressure.

which bears heavily upon the resultant chemistry and physical properties of the metal poured. The reactions of combustion are so simply expressed that they are frequently misleading in the full implication of their meaning.

The most important chemical reactions occurring within the cupola are those involving the combustion of the coke with air because they control the whole melting process. As generally written, these reactions are as follows:

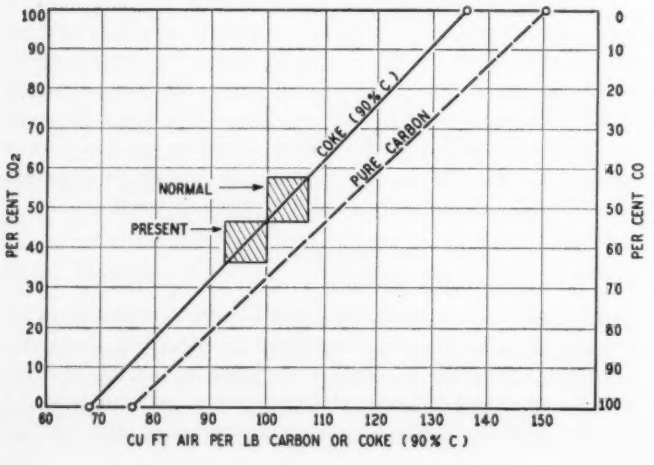
1. $C + O_2 = CO_2 + 14{,}550$ Btu
2. $2C + O_2 = 2CO + 4{,}350$ Btu
3. $2CO + O_2 = 2CO_2 + 10{,}200$ Btu
4. $CO_2 + C = 2CO - 5{,}850$ Btu
5. $2CO = CO_2 + C + 5{,}850$ Btu

In each instance the Btu shown is the amount of heat released per pound of carbon. Equation 2 is the final result of two reactions.

First Stage ..... $C + O_2 = CO_2$
Second Stage .... $CO_2 + C = 2CO$
Final ..... $2C + O_2 = 2CO$

Concerning these reactions, the important point is that they represent individual equilibrium conditions, while in the cupola there are dynamic conditions under constant change, and some of these reactions oppose each other. This means, of course, that each of these reactions proceeds in accordance with the conditions favorable to it, and in magnitudes consonant with overall influences, so that the end products in the cupola represent a composite of the several reactions.

*Fig. 3—Carbon-coke (90 per cent carbon) combustion.*




The simplicity of these reactions as written, without further explanation, is misleading because they do not permit proper interpretation of the possible magnitude under the conditions of actual operation. The point is this—these reactions all proceed at entirely different rates, for instance, reaction No. 1 at 1800 F proceeds almost instantaneously, while reaction No. 4 at this same temperature is considerably slower. Reaction No. 5 is the reverse of reaction No. 4, and at 1562 F proceeds at a rate 166 times slower than reaction No. 4.

It has already been mentioned that reaction No. 2 is a resultant of two reactions rather than a direct reaction as written. If this is so, then reaction No. 3 cannot take place except in some minor capacity. In actual operation, when CO is formed, as under reaction No. 4, in the upper part of the stack above the bed under lower temperature conditions, no oxygen is present, so that for the most part the CO remains as such in the final effluent gasses. For a more complete discussion of the mechanism involved reference is made to Haslam & Russell.[1]

### Time Element Important

Time is an extremely important factor with respect to the extent that any of these reactions can occur and, in fact, is frequently the controlling factor in the resultant composite effect. Its effect also is shifted by a change in the amounts of the reactants.

These reactions can probably be better understood if consideration is given to the various conditions under which carbon or coke can be burned. This is shown in Table 1, which has been adjusted for a coke of 90 per cent carbon. It will be noticed that when the carbon or coke is burned to the maximum $CO_2$ content (no CO), the maximum amount of heat per pound is released, and that at the bottom of the table, where it is shown that the carbon or coke has been burned to a maximum CO content (no $CO_2$), the minimum amount of heat per pound is released. Each stage of combustion is controlled by the amount of air per pound of carbon or coke. It is this wide range of conditions which is responsible for the confusion existing in determining the proper amount of air required for a given cupola operation.

Figure 3 is plotted from Table 1 to show the amount of air required for different combustion conditions of carbon or coke. Figure 3 also shows the normal range of operation with coke and the change under today's conditions because of generally poorer coke available.

Figure 4, also from Table 1, shows the amount of heat released per pound of coke under different combustion conditions, and the change from normal conditions to present-day conditions.

Unfortunately, most of the published tables showing the quantity of air required for combustion have been calculated on the basis of the maximum theoretical heat released. These tables, therefore, should not be used to determine the quantity of air actually required for a given cupola operation.

Figure 4, for example, shows that if the maximum amount of air were used, it would be 136 cu ft of air per pound of coke, while actually present-day conditions require approximately 100 cu ft of air per pound of coke. A cupola cannot be run under the conditions of maximum heat released, for to do so would create a state of excess oxidation, making it impossible to produce commercial iron.

It is known that the oxygen introduced does not remain as such in the process, but is converted to $CO_2$ and CO and, as previously pointed out, there is an optimum condition of combustion establishing the proper ratio of these gases. It is interesting, therefore, to follow the path of conversion of the oxygen to the carbon gases, and Belden's [2] work will serve partially in this respect. The resultant effect of the direction of flow is clearly illustrated in the summary shown in Table 2.

These analyses were taken from a burning coke bed (approximately 8 ft total depth) in a cupola lined to 27 in. with air delivered at a rate of approximately 1000 cfm. The size of the coke used was 3 in. and under. The position of the planes are as follows: A—1 in. above tuyere; B—7 in. above tuyere; C—13 in. above tuyere; D—19 in. above tuyere; E—26½ in. above tuyere.

The location of the sample points, as measured from the lining, are as follows: 1—Center 13½ in. from lining; 2—9 in. from lining; 3—4½ in. from lining.

Of particular interest is the percentages of $O_2$ at point 3 in each one of the planes; beginning at the tuyeres this shows 15.8, 8.9, 4.9, 0.4 and 0.1 per cent of $O_2$. This decreasing concentration clearly reflects the controlling direction of flow of the gases. Of additional interest and considerable moment is the fact that CO exists in all planes. This is clearly indicative that both

TABLE 2—ANALYSIS OF CUPOLA GASES

| Plane | Location | $CO_2$ | $O_2$ | CO |
|---|---|---|---|---|
| A | 1 | 12.0 | 0.2 | 14.2 |
| | 2 | 10.3 | 2.1 | 14.0 |
| | 3 | 4.5 | 15.8 | 0.2 |
| B | 1 | 13.1 | 0.1 | 12.4 |
| | 2 | 12.5 | 0.3 | 12.9 |
| | 3 | 11.5 | 8.9 | 0.5 |
| C | 1 | 11.9 | 0.1 | 14.4 |
| | 2 | 12.8 | 0.1 | 13.2 |
| | 3 | 15.0 | 4.9 | 1.0 |
| D | 1 | 9.8 | 0.0 | 18.1 |
| | 2 | 11.5 | 0.0 | 15.4 |
| | 3 | 16.9 | 0.4 | 4.8 |
| E | 1 | 8.6 | 0.0 | 19.9 |
| | 2 | 10.1 | 0.0 | 17.1 |
| | 3 | 15.2 | 0.1 | 6.8 |

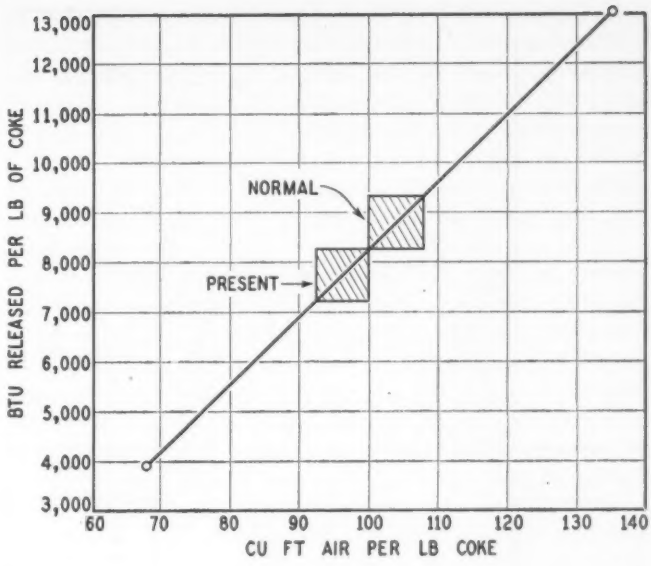



*Fig. 4—Heat released per pound of coke (90 per cent carbon) under different combustion conditions.*

reactions No. 1 and No. 4 are occurring almost simultaneously, even in Plane A, the region of maximum $O_2$ concentration. This illustrates the impossibility of reaction No. 1 occurring to the exclusion of No. 4 and, therefore, it cannot be expected that the maximum theoretical amount of heat from the coke can be made available.

One more point of note is the increase in the CO content as the gases rise. This occurs after the $O_2$ has been consumed, permitting reaction No. 4 to progress more rapidly.

An attempt has been made (Fig. 5) to illustrate the oxygen concentration graphically. The plots of CO and $CO_2$ became too confusing; however, attention is called to the complementary conditions surrounding these two gases, that is, where no oxygen is present as the $CO_2$ increases and CO decreases, and vice versa. Attention is again called to the importance of this relationship on the amount of heat released per pound of coke, and the quantity of air required.

### III—Conversion of Air in Cupola

It has been shown that it is possible, with different air rates, to materially affect combustion conditions of the coke over a wide range. The cupola operator is, therefore, concerned with the factors affecting these conditions. These are: *A*—Cupola dimensions; *B*—coke size; *C*—Stock size; *D*—Amount of air used; *E*—Iron to coke ratio. These factors are discussed individually.

*A—Cupola Dimension:* It has been mentioned that the tuyeres should be of a size properly commensurate with the cupola diameter. Additionally, the tuyeres should be properly positioned above the sand bottom. They should be sufficiently high to accommodate the rate of melting employed, so that slag will not enter them from the well. They should not be so high that an inactive well zone is created. The slag hole must be positioned with respect to the tuyeres so that slag will be kept out of them. In both instances the operator is concerned with preserving the original tuyere dimensions to permit the air to pass properly.

In order to maintain the same melting rate the cupola diameter should be properly repaired to the same

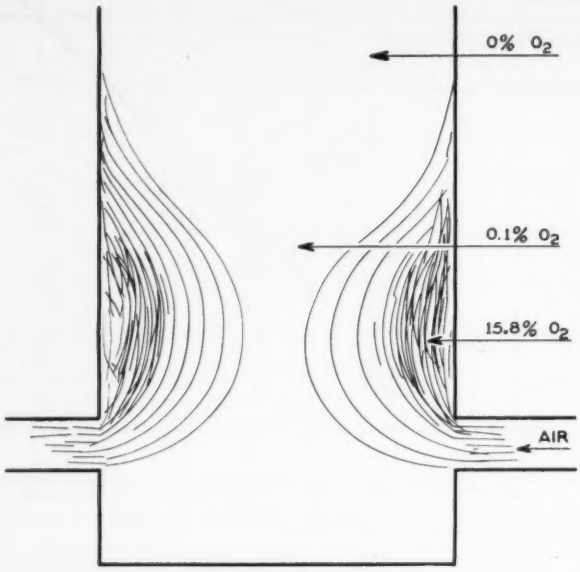



*Fig. 5—Diagrammatic sketch showing oxygen concentration (after Belden [2]) in the cupola.*

dimension each day. A bosh should be properly constructed over the tuyeres to aid in keeping the tuyeres clean during the heat, again directed toward the end of maintaining well-distributed air flow. The dimensions should be carefully maintained each day in order that the bed area will be the same.

The stack height is an important feature because it determines the number of charges the cupola will hold, which in turn determines the amount of preheat the stack can acquire. A lower-than-normal stack, for instance, will always require additional coke, with the corresponding change in combustion conditions.

If repairs are sloppily made the patching material may slip during the course of the heat, aggravating "bridging" conditions because this highly refractory material can descend only past the tuyere openings.

*B—Coke Size:* There are several things which the previous theoretical table cannot show. For instance, the rate of burning a coke can be seriously affected by its combustion properties. It should be kept in mind that the previous tables do not consider time, whereas all of the reactions are definitely influenced by time.

### Coke Surface Areas

A second factor which the tables do not show is that a large coke has less surface to react with the oxygen than a small coke. This is graphically shown in Fig. 6.[3] Here it is noted that the surface area increases in direct proportion to the decrease in the size of the piece. Translating this in terms of its practical effect, it is shown that a small coke decreases the metal temperature and the melting rate, because the larger surface area increases the rate of oxygen consumption and the melting zone is lowered closer to the tuyeres.

Under this condition a higher blast rate is in order, and also additional coke. The coke may also be so small that a considerable interior portion of the bed is not properly burned, resulting in a considerable decrease in the actual melting area of the cupola.

Conversely, a large coke has less total surface area, the oxygen is consumed at a slower rate and free oxygen may result above the bed, causing considerable oxidation of the metal. Under this condition a higher bed must be maintained to prevent this oxidation. Large coke favors faster melting.

*C—Stock Size*: The size of the stock employed affects the operation in two principal ways. When small material is used, the stock density may be so high that proper penetration of the gases is impossible. This will result in a greater proportion of the gases ascending along the walls of the cupola. Here again, this condition will limit proper combustion and proper heat distribution.

If, on the other hand, the stock size is generally large and heavy, the charge condition will be quite open but the total surface of the metal is insufficient for proper absorption of heat in the time allowed. This effect has been observed many times in the cold iron which results from heavy material. These extremes will illustrate the necessity for proper sizing of the metal charged.

*D—Amount of Air Used:* The amount of air required for a given cupola operation is unimportant. It is not a material which is stock piled, and its cost of production is nominal. However, is is important to obtain the proper amount of air for optimum melting conditions and as a matter of record for future adjustments. Figures 3 and 4 show the quantity of air required per pound of coke for different combustion conditions and the present day normal range, but air is not measured in this manner. The unit generally used is cu ft/min or lb/min, and this relationship under different conditions is shown in Figs. 7 and 8.

### Calculating Air Quantities

Attention has been called to the fact that most of the published charts on the quantity of air required for different conditions of operation have not been reduced to a practical basis. This renders interpretation difficult, and Figs. 7 and 8 have therefore been calculated to a more readily usable form.

In attempting to determine the correct amount of air required for a given cupola operation it must be remembered that both the air and the coke are subject to wide variations in adjustment. However, in order to obtain commercial iron, maximum economy of operation, which is affected both by the amount of coke used per ton of iron and the melting rate obtained, must also be considered.

It has been shown that the higher the amount of air used per pound of coke, the greater is the amount of heat released per pound. However, it has also been pointed out that it is impractical to carry this condition to completion. It is worthy of note, also, that as the coke per charge and per cubic foot of air is decreased the melting rate of the cupola increases, but eventually, with the continuing decrease in coke, the iron would become too cold to pour. Conversely, as the coke is increased the temperature increases (reaching a practical limit) and the melting rate decreases.

It is evident, therefore, that there must be some practical range in the quantity of air and coke which can be employed for optimum conditions. Figures 7 and 8 are designed within this range and are based upon the following conditions: Coke—90 per cent carbon; Air—cu ft/min under standard conditions of 60 F, and 30 in. Hg. The air has been adjusted also for an

allowable 5 per cent loss, and further adjusted for the particular stage of combustion under the various coke ratios. Conversion to lb/min is accomplished by dividing cfm by 13, or to convert from lb/min to cfm, multiply by 13.

In Fig. 7, for example, with the air constant at 10,000 cfm, it will be noted that as the coke per ton decreases from 6:1 to 10:1 the melting rate increases from 17½ to 26 tons per hour. Reading the other way on the chart and taking a constant melting rate of 20 tons per hour, it will be noted that if the coke is increased from a ratio of 10:1 to 6:1 the air per minute increases from 7700 to 11,500.

Figure 8, based on the same calculation, shows the quantity of coke consumed per hour at different air rates and at different coke ratios. The two charts have been designed to be used interchangeably. The purpose of these charts is to help establish a starting point for adjusting a given operation.

In comparing these charts with actual operating conditions, it was found that for short heats part of the bed coke must be assigned to the coke per charge. Generally, in heats of 5 hr or longer, the coke between charges (coke ratio) can be used with good accuracy. It was also found that where "coke boosters" are used regularly during a heat and calculated in the coke ratios, the charts deviate from actual conditions because combustion conditions are not uniform.

These charts also are dependent upon reliable coke weights and correct air rates, both of which have been found to vary appreciably under actual operating conditions. These charts, therefore, can be used to good advantage in checking on operations in both respects.

*E—Melting Rate vs. Cupola Diameter:* It has been shown that the melting rate of a cupola is a function of both the amount of coke used and the quantity of air employed. There is still another factor governing the melting rate of the cupola, and that is its operating diameter. There is an optimum melting rate for each size of cupola, and Fig. 9 shows this relationship based upon a melting rate of 9, 10 and 11 lb per sq. in. of bed area per hour. This curve will serve to show what can be expected from a given cupola under normal conditions.

Under the pressure of today's high demand, many cupolas are operating at faster-than-normal rates. From a standpoint of overall castings cost this may be justified, but frequently this fact is not ascertained and actually may not be the case. In any event, it is certainly not advisable where the best iron is desired. If the cupola has a sufficiently large shell diameter it might be possible to increase the operating diameter and establish better overall conditions.

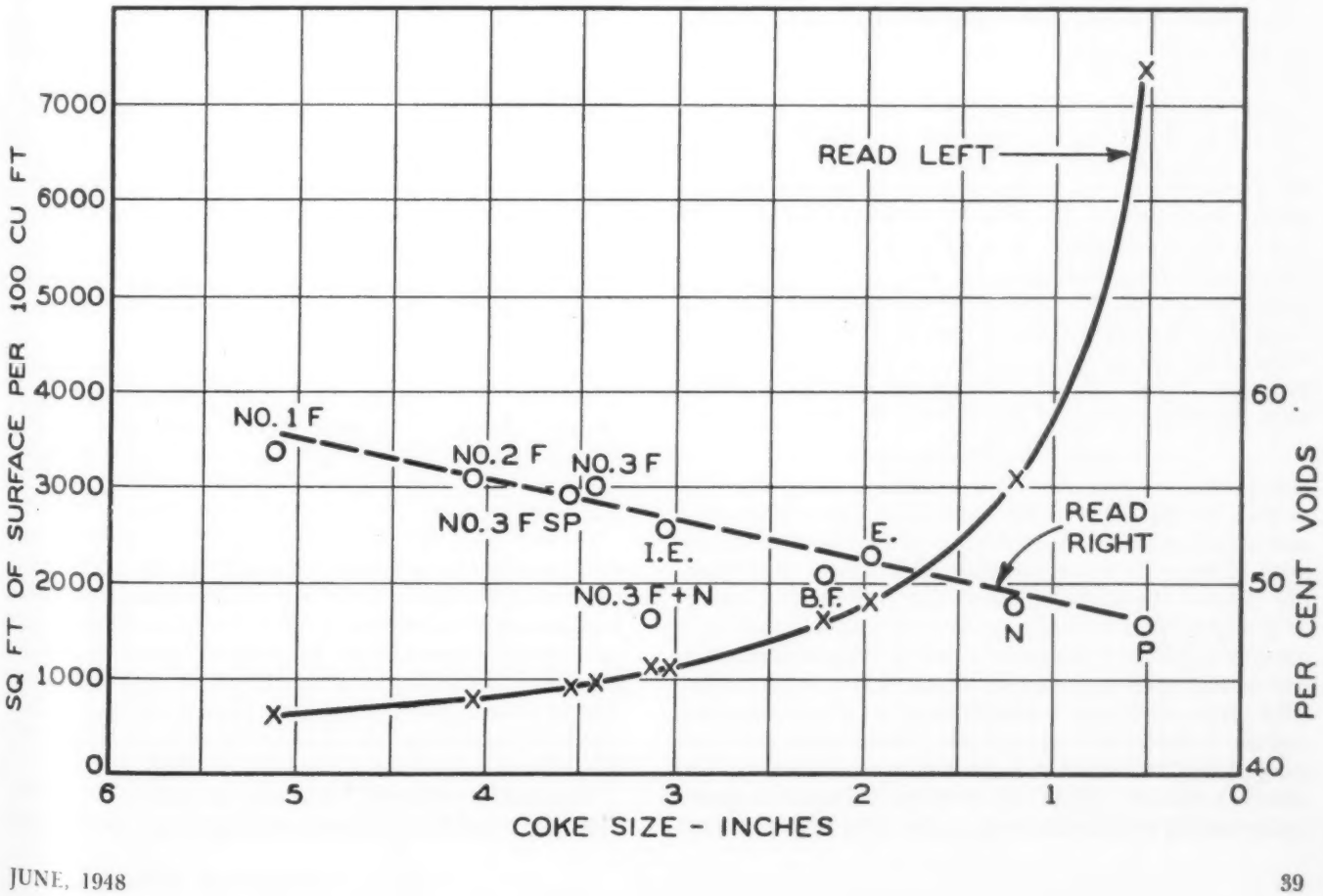
If the cupola is too large for the melting rate required, it should be lined down to the size actually needed. In this manner better ratio, lower costs and far better chemical control is possible.

### IV—Blast Modification or Conditioning

Up to this point the subject has not been treated as it relates to the majority of operations, namely, cold blast operation with the conventional single row of tuyeres. However, operators are interested in knowing what changes take place in an operation when certain blast modifications are introduced. These are briefly discussed.

*A—Two Rows of Tuyeres:* As generally constructed, the second row of tuyeres, which vary in number and

*Fig. 6—Graph showing coke size vs. area, voids.*



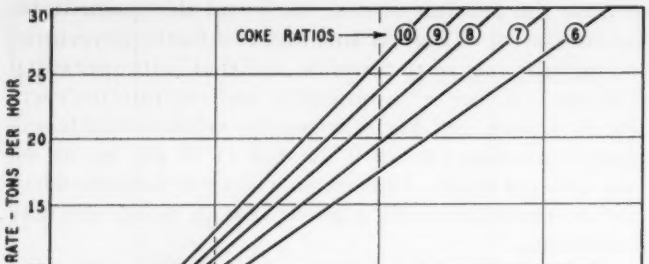



*Fig. 7—Melting rate vs. air at different coke ratios.*

size but are smaller than the main tuyeres, are located 10 to 12 in. above the bottom row. Generally, employment of tuyeres is for the purpose of modifying some inherent difficulty with a particular operation. They do help under certain conditions, but in the writer's opinion the difficulty usually can be corrected without their installation.

The general effect of the second row of tuyeres is to introduce oxygen higher in the bed, necessitating the maintenance of a higher coke bed to offset this condition. Higher temperatures result from this higher bed. It has frequently been noticed that localized burn-out of the lining occurs directly above each upper tuyere in the form of a crater, indicating localized zones of increased activity. This is contrary to what it is wished to accomplish, in that the objective is to maintain uniform combustion conditions across the entire bed area.

*B—Balanced Blast:* The balanced blast cupola, which is a conventional cupola with a special tuyere arrangement, consists of three rows of tuyeres, with the tuyeres in each row smaller in size than those in the previous row below. Each tuyere in the bottom row is equipped with a valve for periodically shutting off the blast in one or more tuyeres. The claims for this cupola are greater fuel economy by virtue of a higher $CO_2$ production in the waste gases. It is difficult to reconcile the claims and the conclusions for this process with the fundamentals of the combustion within the cupola. Actually, the same stage of combustion, namely, a higher-than-normal $CO_2$ content of the stack gases can be accomplished in the conventional cupola by thinning the coke ratio and increasing the air.

### Oxygen Must Be Consumed

It is claimed that the CO initially formed is burned to $CO_2$ by the oxygen introduced through the second and third rows of tuyeres, thus releasing additional heat. This certainly is possible; however, by elevating the tuyeres above the normal zone free oxygen exists at a higher point than in a normal cupola, and this oxygen must be consumed before the gases leave the top of the operating bed or oxidized iron will result. The same correction must be applied as in a normal cupola, namely, raising the coke bed so that the free oxygen will be consumed. Any normal cupola can be run to produce a high $CO_2$ content in the stack gases by operating with a thin coke ratio and a high air rate.

One desirable feature of the balanced blast cupola has been the control valves on the lower tuyeres which, when operated on a cycle or periodic closure, will result in minimizing "bridging" conditions.

In the writer's opinion, with the exception of the control valves, the performance of the balanced blast cupola can be equalled by any other well designed and well operated conventional cupola with a single row of tuyeres.

*C—Hot Blast:* The hot blast cupola is designed for either internal or external heating. By internal heating is meant the extraction of the heat from the stack gases. Obviously, this system will permit greater fuel economy than cupola operation in which the stack gases are lost to the atmosphere.

One type of hot blast cupola burns the residual CO in a stove to preheat the air passing through tubes, while in a second type of internal hot blast the air is conducted through a series of pipes in the section of the cupola below the door to preheat it by means of the sensible heat in the gases. No stack gases are burned in this process.

In the external system a second source of fuel is employed to preheat the air entering the cupola. In this instance, the overall thermal efficiency is reduced

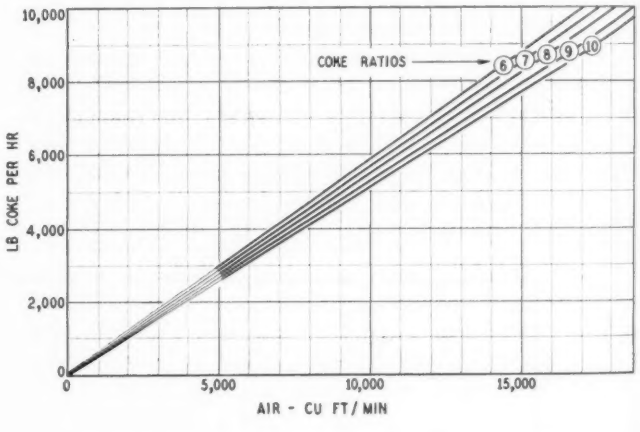



*Fig. 8—Coke per hour at different coke ratios.*

by virtue of consuming additional fuel. The relative merits of either type of hot blast is strictly a question of the economics of initial cost, maintenance, and efficiency in melting.

The benefits of the hot blast system on the cupola operation (disregarding investment costs) is unquestioned. "Bridging" in the cupola is reduced to a minimum. Better coke ratios are possible, which permits faster melting, and higher temperatures are easier to maintain because of producing a cleaner cupola.

*D—Dry Blast or Dehumidification:* In recent years attention has been directed toward the effect the varying moisture content of the air has on cupola operation and metal characteristics. For normal atmospheric pressure the percentage by volume of moisture in saturated air can vary from 0.6 per cent at 30 F to 6.5 per cent at 100 F. At an air rate of 10,000 cfm this would be equivalent to introducing water at the rate of 2.6 lb/min at 30 F and 33 lb/min at 100 F.

Unquestionably this variation in moisture content, which is possible in year-round operation, exerts some

influence on cupola operation. Additional coke is required at the high-moisture-content level because of the heat required for disassociation of the water, and it is further claimed that the hydrogen originating from the water gas reaction exerts an adverse effect upon the metal properties.

Plants using dehumidification systems have generally felt that they have been beneficial to their operation. However, the decision with respect to the use of this equipment still is largely a question of the potential benefits vs. the investment and operating costs, and the writer feels that the full benefits possible with the conventional cupola should first be obtained by rigorously adhering to the well established methods of exact control.

## V—Operation

Having discussed the principles involved regarding the air and its variable effects upon combustion, it seems well to consider a few of the operating practices in vogue. Several of these procedures have been touched upon throughout the previous discussion. The principal features are as follows: *A*—Air rate vs melting rate; *B*—air rate vs. coke ratio; *C*—variation of air to control carbon; *D*—excess air; *E*—insufficient air.

*A—Air Rate vs. Melting Rate:* Referring again to Figs. 7 and 8 attention is called to the fact that if the coke ratio is held constant, the melting rate will increase at given rate with an increase in the air rate, but there is a practical limit beyond which this cannot be carried without encountering difficulties with the iron because of the limiting features of combustion conditions and cupola capacity.

Frequently a shop practice is encountered where the cupola is made to carry the entire burden of a variable shop demand. Within the limit of the . lting rate capacity of the cupola this is satisfactory; however,

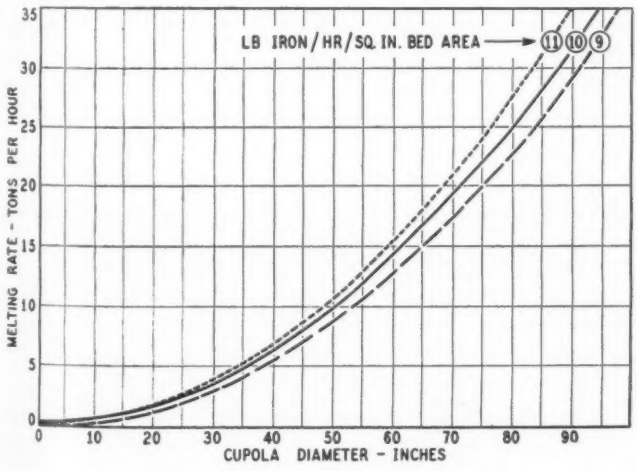



*Fig. 9—Melting rate vs. cupola diameter.*

when a reasonable capacity is exceeded trouble with the metal from one source or another will unquestionably result, with potentially higher losses. When a slower-than-normal melting rate is required, it is almost certain that the metal temperature will drop, again resulting in a higher potential loss unless, of course, excess coke is used.

For the best cupola operation, therefore, a reasonable and constant melting rate should be determined and set for a given cupola. In most instances the work in the shop can actually be adjusted for this reasonable rate and the benefits of consistently good metal will justify this adjustment.

*B—Air Rate vs. Coke Ratio:* Again referring to Figs. 7 and 8, it will be noted that with the air rate held constant an increase in coke will cause a decrease in melting rate. Both *A* and *B* are directly related. The factors limiting these conditions have been discussed in Figs. 3 and 4, relating to desirable combustion conditions within the cupola.

When the operation is in an uncertain state of balance and a persistent drop in metal temperature has occurred or occurs regularly each day at a certain time, the quickest correction is to reduce the air rate. If the temperature drop has been due to a lowering of the bed because of insufficient coke, the metal temperature will recover. In the meantime, a "coke booster" should be added and the coke/charge increased. When these reach the cupola bed the air rate can be restored to its original level.

Too much coke can also cause a temperature drop, but this will be accompanied by a slower melting rate, and the carbons may be higher than desired. A correction would be to initially increase the air until the temperature recovered, followed by a reduction in both air and coke until proper conditions have been established in the cupola.

### Oxidation Conditions

*C—Variation of Air to Control Carbon:* This is a specific example of holding all other conditions constant but varying the air. When conditions in the cupola are within a practical balance it is possible, within certain limits, to increase the air and lower the carbon in the iron and, conversely, to decrease the air to raise the carbon in the iron. In effect this raises and lowers the percentage of $CO_2$ produced or, in other words, increases and decreases the state of oxidation within the cupola.

Control of carbon by this means should be used with extreme caution because if conditions are balanced within the cupola and the air rate increased, it is entirely possible that momentarily the carbon in the iron will be adjusted to the desired analysis but will be followed by a loss in temperature and an undesirable state of oxidation, resulting from lowering of the bed. It is not good practice to vary the air upward or downward during a heat, except in searching for a better adjustment. It would be better to rebalance the composition of the metal mix and then find the proper balance of air and coke to maintain the analysis desired.

*D—Excess Air:* Frequently, the writer has encountered conditions where the blower has a capacity considerably in excess of the melting rate of the cupola to which it is attached. With no metering equipment the operation has been adjusted by adding coke until all of the surplus air is satisfied. The net result of such an operation is, of course, high coke costs, slow melting rate, and difficulty in maintaining desired analyses, particularly if high strength iron of low carbon content is desired. In this instance, it would be much less expensive to install a reliable meter and establish the proper amount of air and coke required. The cost of the meter can easily be justified by the overall savings.

If the higher amount of coke is not added to use up the surplus air, oxidation of the metal must result with consequent poor iron and high shop losses.

*E—Insufficient Air:* Quite frequently the blower has insufficient capacity for the cupola to which it is attached. As the shop demand increases the only way in which more metal can be obtained is to decrease the coke per charge or to extend the length of the heat. Thinning the coke ratio may result in oxidation and lower metal temperatures, with a consequent increase in scrap. If the length of the heat is extended, overtime costs increase. In either event, the less expensive and more satisfactory correction is a larger blower.

Under present-day conditions, where higher coke quantities are required, many blowers have not had the reserve capacity to permit the adjustment dictated. It is advisable, therefore, to correct such a condition, and the cost of the larger blower can be quickly absorbed in the improved condition of melting.

### Summary

1. Quantity of air used in the cupola is greater in amount than any other raw material and exerts the greatest influence on the operation.

2. Entire air system should be well engineered to meet all normal requirements for each installation. When properly designed and maintained it is the one element of the operation which can be made completely reliable.

3. Combustion of coke varies with the amount of air used, and there is an optimum ratio for good cupola operation. The three most important elements in gray iron (carbon, silicon and manganese) are largely dependent on the manner in which the air is consumed. The physical properties of the metal are affected by the same conditions.

4. The air system, the cupola and the melting rate should be coordinated as a balanced unit. The cupola dimensions should be carefully standardized, and designed in all respects for optimum distribution of the gases.

5. The conventional cupola can be designed and operated to give excellent results without the use of special equipment.

6. Can good air control be justified economically? As a practical example, consider the case of a foundry with a melting capacity of 100 tons per day, operating at 75 per cent capacity with a 60 per cent yield. On a basis of 250 operating days per year and with an average casting price of 10c per lb, in 20 years the gross return would be 45 million dollars.

Cupolas and equipment for this foundry will have cost between 25 and 35 thousand dollars. Establishing proper air and combustion control might cost an additional ten thousand dollars or a few hundred dollars.

Savings which may be attributed to improved cupola operation, on a basis of percentage of gross return, would be: 1 per cent saving—450 thousand dollars; 5 per cent saving—2¼ million dollars.

### References


1. Haslam and Russell, *Fuels and Their Combustion*, McGraw Hill Book Company, Inc., 1926, p. 151.

2. A. W. Belden, "Foundry Cupola Gases and Temperatures," United States Bureau of Mines Bulletin No. 54, 1913, p. 13.

3. B. P. Mulcahy, "Foundry Coke: A Critical Study," TRANSACTIONS, American Foundrymen's Association, vol. 52, p. 819 (1944).


## Symposium On Nonferrous Melting Includes Nickel And Lead Alloys

MELTING OF NONFERROUS ALLOYS—copper base, light metals, nickel, and lead—is described in *Nonferrous Melting Practice*, an AIME publication now available through the American Foundrymen's Association. A 117 page symposium on nonferrous melting, the price is $3.00 to A.F.A. members, and $3.50 to non-members.

*Nonferrous Melting Practice* comprises seven authoritative papers. In "Measurement and Control of Temperatures on Smelting, Refining, and Melting Nonferrous Metals," P. H. Dike and M. J. Bradley point out that knowledge of temperature of a metal is fundamental to melting and casting. The discussion and bibliography cover the types and applications of temperature measuring instruments.

H. M. St. John writes on effect of melting on metal quality, pouring temperatures, fluxes, furnace design, and procedure to use with each type of furnace. Entitled "The Melting of Brass and Bronze in the Foundry," Mr. St. John's paper is limited to sand casting copper-base alloys, and includes 25 references.

"Melting and Alloying of Wrought Copper Alloys," by R. S. Pratt, describes raw materials, furnaces, melting practice, refractories, and melting losses. "The Melting of Nickel," by W. A. Mudge, is limited to malleable commercially pure nickel and some high nickel alloys.

In "Melting and Refining Practices for Magnesium," C. E. Nelson discusses primary magnesium process, giving various melting procedures and details of fluxing. Degassification and a new grain refining treatment are described. References are included.

Mechanical and chemical properties of aluminum alloys as related to melting are described in "Melting of Aluminum and Aluminum Alloys," by T. W. Bossert and H. J. Rowe. Continuous melting of lead and its alloys is explained by Albert J. Phillips in "Melting Practice for Lead and Lead Alloys." Drossing rates and melting segregation, and a procedure for production of high quality molten lead are described.

## Milling Cutters Precision Cast

EXCELLENT PERFORMANCE in machining tests has been shown by milling cutters that are precision cast from remelted high speed scrap, an Office of Technical Services report states. This salvage method was developed at the Watervliet (N.Y.) Arsenal.

Circular milling cutters were precision cast from high speed steel scrapped during the war. A master pattern was machined in brass in accordance with dimensions for standard forged cutters, using standard procedures to obtain the desired wax pattern. The patterns were then mounted on aluminum plugs.

After the required baking out period, the cutters were cast, cooled, broken out of the mold and sand blasted. They were then cut from the sprue by an abrasive wheel.

Following heat treatment, comparative tests were run with both precision cast and forged stock cutters. The precision cast cutters proved superior, Watervliet Arsenal officials state.

# PLASTIC PATTERN EQUIPMENT

**Steve Denkinger, Jr.**
**President**
**Atlas Pattern Plastic Works**
**Butler Wis.**

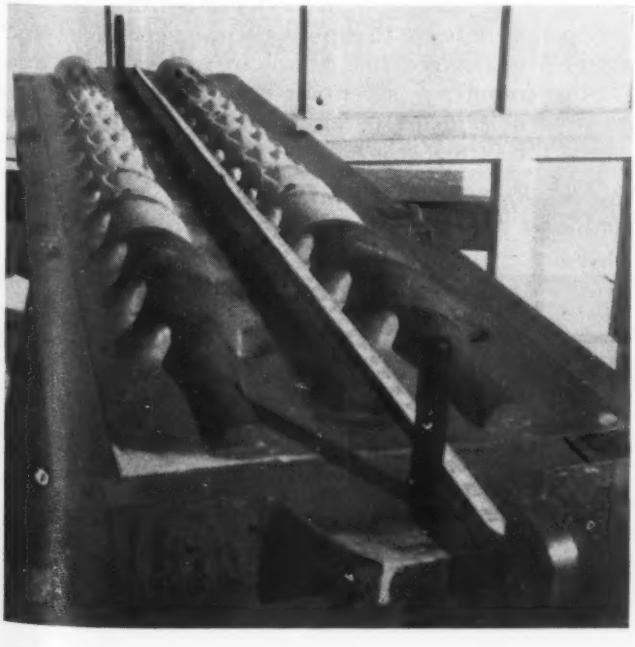
SINCE THE INTRODUCTION of plastic pattern equipment a few years ago many improvements have been made in production techniques. As a result, some confusion has arisen as to certain advantages and disadvantages of the process. It is hoped that the present discussion will serve the purpose of clarifying some of the points in question.

As far back as 1906 small parts were made from the syrupy liquid phenol-formaldehyde resins produced by Dr. L. H. Baekeland. These early casting resins were restricted in usefulness because of limitations in the size of pieces which could be made. It was not until some 20 years later that a phenolic resin was designed specifically for casting. This resin proved to be substantially free from cracking in service and lent itself to the production of large pieces.

Use of casting resins became more extensive in filling the additional requirements which resulted from the demand for mass production of aircraft. Intensive research on reinforced thermosetting phenolic castings led to the development of complicated tooling equipment, which was lighter in weight and more efficient than equipment of this nature used previously. This type of reinforced phenolics was first used about 4 years ago in the manufacture of plastic patterns.

Although faults were found, they could be corrected, and the material seemed to have a tremendous future. Foundries began to use plastic equipment and proved that it could stand the severe punishment received in the foundry. Improvements are constantly being made in plastic pattern technique, and formulas of different types of resins are tried to better this type of equipment.

*Cope half of plastic equipment used under sandslinger.*



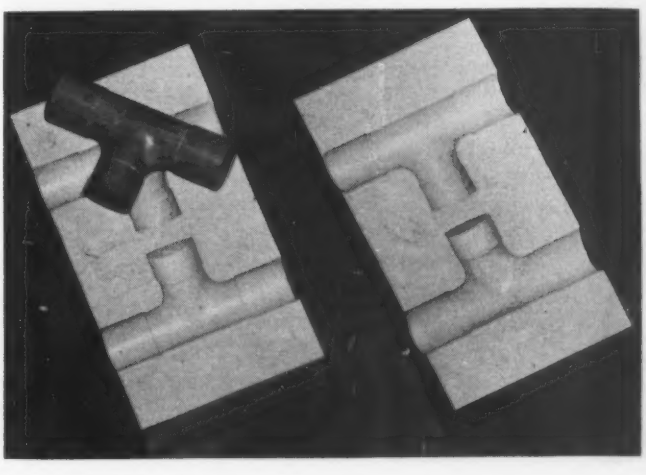
Cast phenolic resin in itself is a hard, abrasive-resistant, brittle material, and it must be incorporated with a binder in order to overcome its brittleness. The type of binder used is important, as there is a large variety of binders on the market and the selection of the proper one is a long and tedious process. The use of a filler material in cast phenolic plastic tends to strengthen the material and lessen the shrinkage, which normally amounts to about 0.0015 in./in. If necessary, the shrinkage can be controlled to an exact minimum.

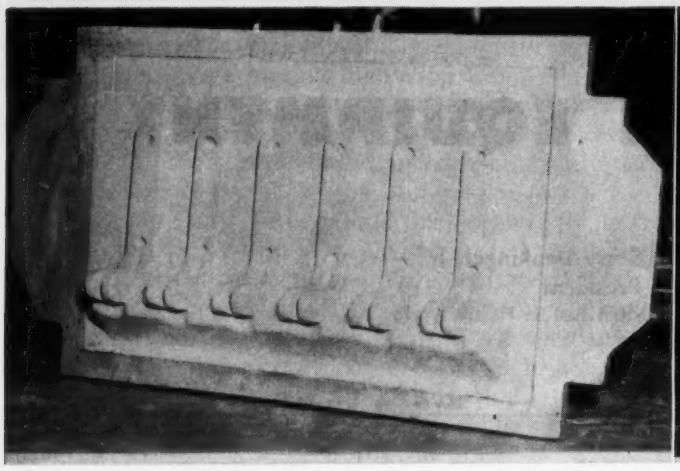
### Structural Strength and Weight

Plastic pressure plates are closely grained, fine and compact. These qualities produce high surface smoothness without ram-off of sand. It is impervious to water, oils and acids. It does not oxidize nor have any other surface accumulations in use or in storage. Sand-abrasion resistance of plastic pressure plates is three times that of aluminum. The specific gravity of plastic is 1.7. Its approximate weight is ¾ oz per cu. in., or about one-half the weight of cast aluminum. Plastic pressure plates have been proved to have all strengths necessary for use as foundry production pattern equipment. It is superior in strength to wood and, for all practical purposes, equal to that of metal.

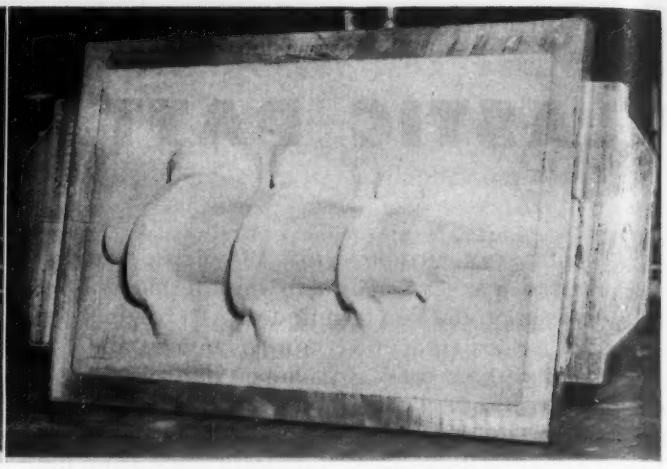
Plastic patterns can be drilled, tapped, jig bored, milled, machined, sanded and scraped in the same manner that wood and metal can be worked. For the most part, machining of phenolics may be accomplished on standard equipment; however, certain modifications in tooling are required. Inasmuch as the material has

*Plastic core box made from dummy wood core.*





*Squeezer plate used in a malleable iron foundry.*



*Squeezer plate equipment used in a steel foundry.*

low heat conductivity, feeds cannot be forced. The abrasiveness of phenolics suggests that tools for mass production should be nitrided or carbide tipped to insure the greatest efficiency. Because of the comparative softness of plastic, tools which will remove chips faster than those used for metal are required. The resiliency of materials calls for tools with 10° to 20° clearance and 0° to negative rake.

### Machinability, Pattern Changes and Repairs

Drilling operations are most successfully accomplished by using speeds of 3,000 to 12,000 rpm on small drills up to ¼ in. When cutting deep holes it is advisable to back the drill out frequently to prevent scorching and discoloration.

Regular standard taps may be used for tapping cast phenolics, but the ground high-speed-steel taps have proved more satisfactory. Very little rake and plenty of clearance are desired, as some of the highly abrasive materials occasionally cause the taps to cut very close to size, and cord binding is often experienced when backing out. Better results and longer life are achieved by using taps which have three flutes instead of four.

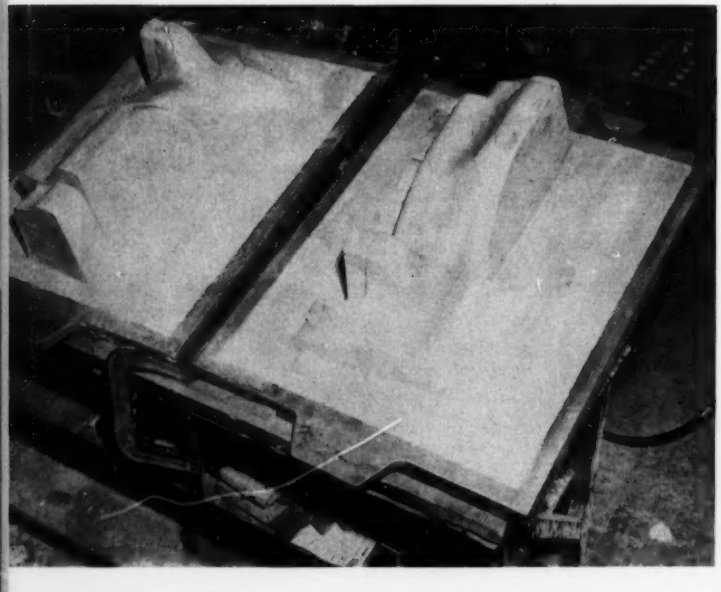
Plastic patterns have great durability, but if struck a sharp glancing blow the material may chip but will not dent. If chipped or otherwise damaged they may be easily repaired with a patching material which handles like modeling clay or plastic wood, forming a tight bond with the virgin material and air drying in about 24 hr at room temperature. In minor pattern repairs, on the job, this drying time can be cut to less than a half hour by use of an ordinary infra-red heat lamp. When dry the patch can be worked as easily as the virgin material.

Working qualities of plastic patterns are excellent. They draw exceptionally well due to the gloss-like surface, and usually it is not necessary to use a parting agent, either dry or liquid. The plastic material is a non-conductor of heat and does not promote condensation. It has no thermal reaction to hot sand and requires less vibration and rapping in drawing. Plastic patterns can be brought from "cold" pattern storage and put in the sand at once without preheating and without sand sticking. They will not warp if placed near a hot radiator and will withstand heat up to 375 F, with no limit on the cold side.

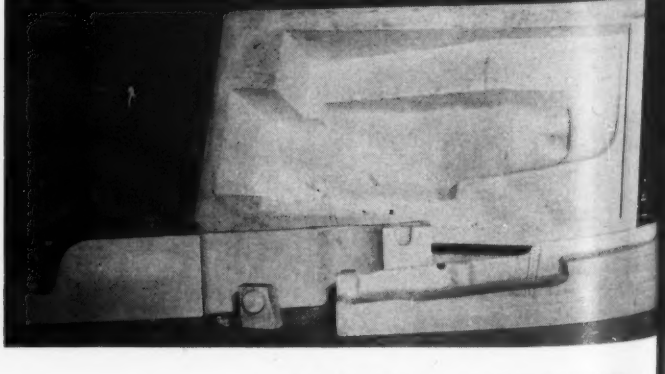
### Uses and Advantages

Plastic patterns have been in use about 3 years. During this period there has been no evidence of internal or external deterioration, whether the pattern had been in use or in storage. Laboratory aging tests over an 8-yr period indicate that plastic equipment life should equal if not exceed that of any material now used in making foundry production patterns.

Any single shrink pattern of any size can be repro-



*Plastic cope and drag equipment (left) and core box and loose pieces (below) used with the pattern plates.*



### Mechanical Properties

| | |
|---|---|
| Shrinkage, in./in. | 0.0015 |
| Rockwell Hardness | 115 |
| Flexural Strength, psi | 12,000 |
| Modulus of Elasticity in Flexure, psi $\times 10^5$ | 5 to 7 |
| Impact Strength, ft-lb/in. of notch (ASTM) | 0.24 |
| Compressive Strength, psi | 12,000 |
| Tensile Strength, psi | 5,000 |

duced as many times as needed in plastic. The pattern to be reproduced can be a master or working pattern, loose or gated, cope and drag, match plate or core box of wood, metal, or any other material.

In many cases a single shrink pattern is delivered to a foundry with an order calling for a large quantity of castings. This pattern can be used to reproduce as many patterns as needed, or a plastic pressure plate. This production plate can then be used to produce the castings at a cost considerably lower than would be the case if a single pattern were used.

Gated patterns can be used as a match and reproduced in plastic, using the gated pattern as a master. Broken pressure plates can be remade in plastic directly from the master plate.

Some foundries have match plates which they feel would be more suitable as cope and drag equipment. This change-over can be accomplished by making an impression of one side of the match plate, making it of plastic and then using the one side of the match plate as the drag and the plastic as the cope.

In other cases the foundry may not be getting the production required out of a single match plate. Duplicate equipment can be made of plastic in any amount desired. Core boxes can be duplicated from new or old wood or metal core boxes, and can also be transformed into blower boxes.

Experimental work has been carried out in the use of plastic blower boxes, and the results have been encouraging. Certain defects have been found in the use of plastic for blower boxes, but these are gradually being overcome. There are plastic blower boxes in use today that measure 28 in. long and 8 in. wide. Several blower boxes have produced well over 8,000 cores without showing wear.

Cope and drag plastic patterns are in quite extensive use and have proved capable of withstanding severe punishment. The largest one made measured 72x48 in. Some are being used under sandslingers and show little or no wear.


#### Acknowledgment

The author wishes to acknowledge the courtesy of Howard Foundry Co., Chicago; Oliver Corp., Charles City, Ia.; Batavia Metal Products, Cedar Falls, Ia., and Calumet Steel Foundry, Hammond, Ind., in furnishing the photographs used in the paper.


## Making Precision Molds and Cores Told By Technical Services Office

PRECISION CASTING of various metals in sand molds and cores, as developed by Croning & Co., Hamburg, Germany, may be an important advance in foundry practice for certain types of castings, according to the process described in a report (PB-81284) available at the Department of Commerce office of technical services, Washington 25, D.C.

Known as the "C" process, the method employs a dry mixture consisting of a high-grade silica sand and a plastic binder in powdered form, and appears to be especially important in that small pipe fittings, now cast in malleable iron, may be cast in steel, according to the report.

A simple procedure for making molds from the sand and plastic binder mixture is described. The half pattern, gate, and runner are permanently fixed on a metal plate. A set of beveled bosses and corresponding cavities are machined on the pattern plates, and these shapes, when transferred to the mold halves, serve as positioners to insure exact matching.

Heated to about 200 C, the pattern unit is sprayed with a paraffin solution which provides a uniform oily film. The plate is next clamped, pattern downward, over a box containing the molding material, and the assembly quickly inverted. The molding material falls, covering the surface of the hot plate and forming a continuous coating over the pattern surface. The coating builds up to 3- to 4-mm thickness in about 6 sec.

The pattern plate with the adhering coating is then placed in an oven at 300 C for 2 to 3 min, resulting in the conversion of the resinous binder material to a hard, insoluble, bakelite-type plastic which bonds the sand grains. The half mold is a thin shell with sufficient strength and stiffness to withstand the pouring operation. Much the same procedure is followed in making cores.

In casting, liquid metal is poured into the mold in the conventional manner. The casting is easily removed from the mold as the sand does not burn-on or stick to the casting surface. Cores can be removed by lightly tapping the casting.

Castings of iron, steel, and aluminum made by this method were examined in as-cast condition and were found to have unusually smooth and clean surfaces. The fin around the parting line was quite thin and could be easily removed. Shot-blasting was unnecessary. The heaviest casting examined was a 6 to 8-lb pipe fitting with cast threads. The manager of the plant stated that valve housings had been made in straight carbon, vanadium, and manganese steel with 2.5 mm wall thicknesses.

## To Revise Refractories Directory

A REVISAL OF THE PRESENT ISSUE of the *Directory of the Refractories Industry,* published in 1942 by the American Refractories Institute, St. Louis, is being planned. The Directory contains names and addresses of manufacturers of refractories, location of plants, and an alphabetical listing of refractory products by brand names.

It is the desire of the Institute to have the Directory cover the entire industry and, while the Institute has contacted all manufacturers about whom it has information, Institute officials believe that some may have been omitted. Institute President W. J. Westphalen requests that any refractory manufacturers not already listed contact his office at the Railway Exchange Bldg., St. Louis, Mo.

# BLACKHEART MALLEABLE IRON

## *Solved and Unsolved Metallurgical Problems*

**H. A. Schwartz**
**Manager of Research**
**National Malleable & Steel Castings Co.**
**Cleveland**

**Presented as the tenth Edward Williams Lecture at the Annual Conference of the Institute of British Foundrymen, in London, June 8-11, 1948, this paper is a comprehensive resumé and bibliography of fundamental information relative to the metallurgy of blackheart malleable iron.**

IN ENGLAND, the interest has been mainly in whiteheart rather than blackheart malleable iron. Whiteheart malleable has no commercial significance in the United States, although blackheart malleable production has reached about one million tons per year. Recent British literature reports work quite pertinent to American problems, much of this emanating from the British Cast Iron Research Association. Since American malleable founders are concerned with the control of decarburization, while the British have been interested in its promotion, much that is novel to Americans is found in the work that Jenkins and others in England have done in this field.

It will have been inferred from this introduction that the writer's interest is much more with regard to metallurgical principles than in the details of plant operation or equipment.

The ultimate object of the American industry is to produce metal of the quality required by the ASTM specifications for tensile strength and which shall be machinable at high cutting speeds and can be produced by the most economical methods. Obviously some compromise may be required. In addition to cupola malleable and the pearlitic type, the ASTM recognizes two grades of malleable iron. These are designated by code numbers 32510 and 35018, respectively. The first three figures indicate the yield strength (in hundreds of pounds per square inch); the last two figures indicate the elongation. The two grades are required to have tensile strengths of 50,000 and 53,000 psi, respectively.

These numbers, unfortunately, are not the result of well-founded research but represent really a consensus of well-informed opinion. It is well known that there are considerable variations in tensile strength corresponding to a given yield strength, and also in the tensile strength-elongation relation.

### Combined Carbon

Since the American product, in general, is almost completely free from combined carbon and since the yield ratios do not seem related to composition in any way, this represents the first unsolved problem. One may wish to consider that up to the yield point the deformation is largely elastic and a change of volume may be occurring, whereas between the yield strength and the tensile strength the deformation is largely plastic and unaccompanied by a change of volume.

A second unsolved problem is the observed fact that metal containing a considerable amount of pearlite varies considerably in elongation for similar amounts of combined carbon. In this connection one is left to consider the effects of decarburization of surface metal on the apparent ductility of the alloy.

The form of the graphite aggregate, a field in which Morrogh's work may be a most important guide, may also be of importance in explaining the foregoing anomalies.

It is surprising, but probably well established, that malleable iron whose graphite is in relatively few large nodules is more ductile than the identical metal so treated as to contain perhaps one thousand times as many nodules, and quite dense ones at that.

### Tensile Strength—Graphite Content

It is entirely plausible that the tensile strength of malleable should be a function of the amount of graphite present. Yet the change in tensile strength produced by small changes in graphite content in the general region of 2.5 per cent carbon may be at the rate of 12,000 psi per 1.0 per cent carbon in some operations, and 29,000 psi in others.

Originally, we were satisfied with the gross conclusion that there was a direct relation. Now we must seek an explanation of the quantitative differences. The effect of graphite on the modulus of elasticity of malleable iron is almost exactly in proportion to the amount present. The correlation of this modulus with density is of a very high order indeed.

Again, we may have a manifestation of the maintenance of constant volume for platsic deformation and an alteration of volume in the elastic range. Perhaps we should consider such effects, and hence a graphite form. A relation to form is plainly evidenced by the fact that the effect of a given amount of graphite in gray iron on the modulus of elasticity is very different from the effect of the same amount on malleable iron.

The effect of elements other than carbon upon the mechanical properties of completely ferritic malleable has at last been brought into some kind of order. In

blackheart malleable all of the sulphur is present in combination with manganese. It is difficult to obtain any large mass of data which may be supposed to represent a single universe for statistical study of the effect of manganese sulphide. By selection of some appropriate groups, however, and intercomparison, it has been shown that, volume for volume, manganese sulphide affects the properties by something of the same order of magnitude as graphite.

### Element Concentration

Statistical studies as to the effect of manganese, chromium, silicon and phosphorus have been made based on thousands of analyses. One actually determines, of course, the rate of change of strength with concentration. Extrapolation to pure iron yields impossible values. Furthermore, the effect of silicon as determined by these statistics is a decrease in tensile strength, a result not to be anticipated from the solution of an element in ferrite.

Work on medium-carbon normalized steels has finally unearthed a systematic treatment of the fact that the effect of a given change of concentration of a specific element depends upon the concentration of all the elements present. Empirically it is true that if the effects of all the elements present be summed up, assigning to each a potency which has been experimentally determined, then the actual tensile strength is a probability function of the number so obtained. This means that the effect of a given change of composition is not a function of the existing composition but of the existing tensile strength; the latter not directly proportional to composition.

This reasoning was transferred to malleable iron on the basis of a comparison of the microhardness of its ferrite and of certain synthetic ferrites containing certain concentrations of the elements. A simple treatment was found to be the expression of the effect of each alloy on hardness in terms of an equivalent amount of silicon followed by a graphic representation of ferrite hardness in terms of equivalent silicon. The relative effect of given concentrations of two elements dissolved in ferrite is in a constant ratio within the range of these experiments.

A translation into effect on malleable iron still has an imperfection for plainly, since statistically there is no doubt that silicon is a weakener, we are confronted with a strengthening effect in ferrite. This is very probably due to an increase of sprawliness of graphite. It might be that a study of the effect of silicon on the tensile strength of whiteheart malleable, in which apparently graphite is always spherulitic, would throw further light on this reasoning. There are those who have thought that silicon could be present in malleable as the element, an idea for which the writer has seen no evidence.

### Hydrogen Affects Properties

An unsolved mystery is how hydrogen can affect the properties of malleable iron. The hydrogen content of all malleable iron is practically the same, having come to equilibrium in the annealing process. The mechanical properties of the product seem to bear some systematic relation to the hydrogen content of the hard iron. Attempts have been made to explain the effects of various elements on the properties of ferrite in terms of atomic sizes or configuration, with negative results.

As a practical matter there is little importance to be attached to elements other than carbon, as far as engineering properties are concerned. Few subjects, however, have so interested the experimenter as their influence on graphitizing rate.

The mechanism of first-stage graphitization, that is, above the critical point, seems to be quite well established. Details may require further study. It can be said with considerable certainty that the graphitizing rate is always determined in the beginning either by the linear crystallization velocity of graphite or the rate of solution of cementite. The former is the usual condition but there is evidence which can be interpreted as a retardation of cementite solution by the presence of the sulphide films first reported by Levy. After but little graphite formation the determining factor as to reaction rate is the migratory rate of carbon in austenite. To a limited extent, when graphitization is nearly complete, the rate of decomposition of the carbide governs.

Largely because it is no longer usual to begin graphitization below the critical point, less attention has been given to the initiation of graphitization at such temperatures. Above $A_1$ the conditions have been expressed in the form of equations. These are somewhat complicated and incidentally represent about 1500 man-hours of work in their derivation and checking.

### Graphitization Occurs in Two Stages

The mechanism by which graphitization is completed with liberation of ferrite is of enormous industrial importance. A major handicap in its theoretical elucidation long lay in the lack of appreciation of the fact that it actually occurs in two stages. One is a very rapid one, occurring between the $A_1$ stable and $A_1$ metastable temperatures and involving the conversion of austenite into graphite and ferrite. This process may perhaps be so fast as to make its stepwise study difficult. It is about ten times as fast as is the reaction just above this range, and about one hundred times as fast as that just below it. Given even a reasonable cooling rate, graphitization can be entirely completed by the time the temperature falls below the metastable critical point.

If this procedure is adopted, there is no need for information as to completion of the reaction at lower temperatures. If not, the problem lacks specificness, unless we consider the sudden cooling of an alloy in equilibrium above the critical range to a temperature below that range. This condition has practical application mainly in the making of "pearlitic" malleable. In this special case the problem could, perhaps, be approached by the same principles used in studying primary graphitization above the critical range.

One of the numerical constants in the graphitizing rate equations is the number of nodules per unit volume. Be it noted in passing that although there is a general relation between the number per unit area and unit volume, the latter is the characteristic figure. In the field of what determines this number there is still much to be learned.

Morrogh teaches that graphite crystallizes on sulphide inclusions. Admittedly this is frequently so, but it is certainly not true that the number of nodules equals the number of such inclusions. White cast iron quenched from, say, 1000 C and then graphitized, has

many hundred or even several thousand times as many nodules per unit volume as when graphitized without prequenching. There is no reason for believing that the preliminary treatment alters the number of sulphide inclusions. Furthermore, many sulphide inclusions are found about which no graphite grew, and on the other hand there are graphite inclusions in which one can see no sulphides. The latter may, perhaps, be an oversight in that the microscopic plane does not pass through the small sulphides in the larger graphite nodules.

It has been shown that graphite nodules first form, certainly preferentially and perhaps always, at cementite-austenite interfaces, and the area of this interface is increased by precipitation, during reheating, of cementite particles from martensite produced in quenching. It appears that the formation of martensite is necessary to make the process effective. Sulphide and other inclusions have some tendency to precipitate on this same interface.

Since all of the enumerated determining factors for the beginning of graphite growth represent areas of high energy state, it may perhaps be true that these states themselves are the determining factors in starting nucleization. The form in which temper carbon occurs has already been frequently referred to as of major consequence.

Having no contact with irons containing iron sulphide, we in America first learned of the existence of the dense spherulitic type of nodule from British publications and by the examination of samples of British origin. We did know that when temper carbon is formed and grows at high temperature, the number of nodules is greater and they are more sprawly than if graphitization takes place at lower temperatures. We have also demonstrated that temper carbon initiated and growing below the $A_1$ point is in quite spherical masses which, however, are not as dense and have not the high order of crystallinity of the spherulitic inclusions in British whiteheart malleable. Furthermore, it is known that the addition of tellurium promotes the formation of dense temper carbon which is not spherulitic, although approximately equiaxed.

### Composition Influences Graphitization

Graphitization is influenced in large measure by the composition of the hard iron. We know that with the exception of vanadium, whose carbon compound (or iron-carbon compound) is stable at all temperatures, the effect of alloys is much more marked below the critical point than above. Palmer has recently substantiated this point.

There is little completely convincing knowledge as to the mechanism by which composition alters graphitizing rate when it does not, as in the case just mentioned for vanadium, merely introduce a corresponding amount of a stable phase. Silicon, nickel and manganese (except as sulphide), and chromium, are in considerable part contained in the carbide phase, and molybdenum entirely so. Copper could not be studied by the techniques used.

Further investigation is lacking but it appears likely from the general character of x-ray spectra that these elements merely substitute atom for atom, for iron, and do not form new compounds. Indeed, there is evidence that at temperatures above $A_1$, cementite is no longer $Fe_3C$ but first becomes richer in carbon, approximating $Fe_2C$, and then poorer. The type of crystal lattice is unaltered and the lattice is apparently stable irrespective of the exact number of carbon atoms which it contains.

### Sulphide Films

Many years ago, Levy reported the formation of iron-sulphide films in and around cementite particles. The pictures were not completely convincing and the writer has never found an observer who claims to have seen these structures.

Nevertheless the presence or absence of allotriomorphic sulphide films would explain many things. A sulphide phase separating from the alloy during freezing, while the sulphide is liquid, will produce an allotriomorphic film of the sulphur compound. If the freezing point of the sulphide complex is above that of the parent metal it will separate as a liquid drop or as a crystal and be present ideomorphically.

The presence or absence of allotriomorphic sulphides will, however, explain many experimental observations. We lack much data regarding free energies of formation but it is fairly reasonable to suppose that the stability of the sulphides is in the following order: iron, manganese, tin, cerium and lanthanum. It is also reasonably certain that the melting points of iron and tin sulphides are below those of the iron and the others mentioned. If iron sulphide is present, graphitization is retarded (allotriomorphic phase). If manganese is added, graphitization goes on (ideomorphic stable MnS). If tin is now added, graphitization is retarded (the still more stable tin sulphide being allotriomorphic). Adding a rare earth restores graphitization (ideomorphic stable sulphide).

### Graphitization Accelerators—Deoxidizers

Selenium and tellurium are, to some extent, equivalent to sulphur. Many graphitization accelerators—silicon, aluminum, zirconium and titanium—are also deoxidizers, and until experiments are made with completely deoxidized metal it may be argued that it is absence of oxygen rather than presence of these elements that produces the result.

The argument would appear to be invalid in the case of silicon, the only one of the series whose effect is known as a function of concentration. The graphitizing rate is multiplied equally by equal increments of silicon throughout the entire useful range, which is scarcely compatible with a deoxidization theory.

Nickel and copper are fairly good accelerators and can scarcely be thought of as deoxidizers. Aluminum, zirconium and titanium are potent in extremely minute concentrations of the order of a few hundredths of one per cent, which makes the mystery all the greater. Nucleization, possibly by the oxides of these metals, is suspected but preliminary surveys seem to show that acceleration is produced without marked increase in nodule number.

The retarding effect of chromium, manganese or molybdenum could be ascribed to a stabilizing effect on the iron carbide were it not for the fact that graphitization appears to still be controlled in rate by the migratory rate of carbon. Perhaps ultimately the atomic physicists will be able to tell us of a mechanism by which these elements, which are prone to combine with carbon, should also retard migration of carbon.

Retardation of graphitizing by hydrogen is known to be accompanied by some decrease in nodule number, but also the rate of growth of nodules is retarded. There remain the alternatives of a decrease in the migratory rate of carbon through the gamma lattice containing interstitial hydrogen atoms, or a decrease in surface per unit volume. The known acceleration by carbon of hydrogen diffusion in low-carbon steels does not appear to suggest a retardation of carbon diffusion by hydrogen.

The element boron is of peculiar interest. In concentrations of a few thousandths of one per cent it greatly accelerates graphitization without any initial marked effect upon nodule number. Above some 0.003 per cent the nodule number begins to increase suddenly and enormously. The effect on graphitizing rate decreases in intensity but is still marked in the region of 0.10 per cent, although with marked deterioration of quality.

Concentrations of one per cent or so completely inhibit graphitization and, strangely enough, white cast irons of conventional composition to which such amounts of boron are added have the metallographic appearance of a hypereutectic iron-iron carbon alloy. For scientific reasons an exploration of the x-ray spectroscopy of the boron-carbon iron alloys should be undertaken, although there is no particular practical need for such knowledge.

Primarily graphitization during freezing is, of course, to be shunned like the plague. Laplanche has lately greatly improved our knowledge of the carbon-silicon ratios necessary to control this factor. He greatly systematized our understanding and interpretation of earlier American observations, and has, it is to be hoped, disposed of for good the fallacious diagram of Maurer which had been ignored by malleable metallurgists because of its evident lack of utility.

Elements other than silicon which are normally present in blackheart malleable seemed to have little effect on primary graphitization, although this is not true of the active graphitization promoters such as aluminum. Incidentally, alloys containing several per cent of aluminum are ungraphitizable.

### Gases and Graphitizing Rate

It may occasion surprise that the ambient gases can greatly alter the graphitizing rate of a given white cast iron. Taking the graphitizing rate *in vacuo* as standard, graphitization in hydrogen, or in gases which, at annealing temperatures, dissociate with liberation of hydrogen, definitely retard graphitization. The facts with regard to atmospheres initially containing anhydrous ammonia are well established, and observations on hydrocarbons (acetylene, for example) which dissociate into the elements indicate a similar trend.

Nitrogen and argon, and presumably also the other inert gases, behave like a vacuum, but mixtures of $CO_2$ and CO, although not either gas alone, promote graphitization. Honda and Murakami suggested in a British publication that all graphitization took place by the alternate oxidation of the carbon of cementite by carbon dioxide and the deposition of graphite from the resulting carbon monoxide with resulting reformation of the higher oxide. The ability to graphitize in the absence of oxygen speaks against this hypothesis.

A very pure iron carbon alloy containing about 0.75 per cent of combined carbon, when heated at a temperature a little below $A_1$ for some three months in pure argon at approximately atmospheric pressure, lost a major part of its carbon. A metallic gray powder found in the tube, which may very well have been graphite, was unfortunately not identified as such either chemically or by x-ray spectrograph. There seems here to be clear evidence that the free energy of graphite not embodied in ferrite is less than the free energy of that substance *in situ* in iron.

### Metal Pressure

An effect of pressure of the metal on included graphite may be suspected. It has been noted that an increase in pressure on a $CO$-$CO_2$ atmosphere, which should favor the decomposition of carbon monoxide into carbon dioxide and carbon, has been observed to accelerate graphitization above the critical point, but in the case of the particular gas compositions used, a pressure of a few atmospheres completely suppressed subcritical graphitization.

It is quite difficult to suggest an explanation. Even if, at high pressures, the lines marking equilibria of $CO$-$CO_2$ mixtures with graphite and cementite respectively, as a function of temperature, intersect in the region of 700 C, there still remains the question of how a pressure on the outside of a piece of metal has an effect near the center of the $\frac{7}{8}$ in. diameter specimens on which the observations were made. The question received some light from the fact reported by the investigator that graphitizing appeared to be inhibited more in the "second stage" near the surface of the casting than near the center.

The effect of the surrounding gas upon decarburization and the producing of low-carbon rims which graphitize with difficulty is another matter. The formation of decarburized rims is desirable, especially in high-carbon iron, from the point of view of increasing elongation. Deterioration of graphitization is, of course, objectionable.

The subject has been studied somewhat thoroughly only where the carbon is removed by oxidation. Removal by hydrogen is also possible; it having been shown that, at a temperature as low as 200 C, hydrogen purified by bubbling through the liquid alloy of sodium and potassium removed carbon readily from white cast iron. The particular hydrocarbon formed was not identified but was presumably methane.

### Decarburization

Work of various investigators with regard to the equilibrium constants of the reaction between carbon, as such, or as cementite, hydrogen and methane, suggests that decarburization is possible at temperatures where the hydrocarbon is fairly unstable. Since the use of hydrogen would, of itself, retard graphitization, the reaction with this gas has been of less interest than that with $CO$-$CO_2$ mixtures.

In this field you, in Britain, who wish to produce decarburized castings without scaling, have made more progress than we have in America. We have done little on the matter of rate of carbon removal and, if the writer understands the published work, then you in Britain have been in a position to conclude that primarily a diffusion of carbon in iron is involved. This seems to be true with the limited degrees of decarburization in which we have been interested.

We were quite surprised to find in our own work that

ferrite rims could be formed at temperatures above the $A_1$ point of the parent alloy. Further investigation showed that they did not form above the $A_3$ point of the alloy in its decarburized state. We were earlier aware that carbon would not migrate from a high-carbon iron into approximately pure ferrite at temperatures below the latter's $A_3$ point.

It would now seem that, within the depths of ferritic rims with which blackheart practice concerns itself, say from 0.01 to 0.10 in., the migration rate of carbon in alpha iron must be enormously rapid as compared with its migration in gamma iron in order that carbon may have migrated through this zone to the exterior under an extremely small gradient. Comparing this with the experiment previously mentioned, it may be that the diffusion into ferrite below its $A_3$ point was so fast as to produce very wide zones in which decarburization was at so low a concentration as to escape microscopic detection.

For a considerable time it seemed that in the presence of ferrous oxide, under conditions which should insure the formation of an atmosphere in equilibrium therewith, the commercial white irons still oxidized, converting iron into one of its oxides. This anomoly was, however, traced to the great tendency of ferrous oxide to absorb oxygen at room temperature. Precautions to assure the absence of higher oxides resolved the difficulty.

It now appears that the silicon, manganese and other elements present in normal practice do not, at least to any great extent, alter the equilibria between CO, $CO_2$, Fe and FeO. These equilibria, including those involving the presence of carbon as cementite, have been long and thoroughly investigated, and the writer's present thought is that there is little need to carry that portion of the work over into investigations of the impure alloys of commerce.

### Subscale Formation

Oxidation of silicon in silicon steels has been the subject of study, and similar experimentation is being carried forward on white cast iron. It appears that any conditions which result in the formation of ferrite rims are likely to result also in the formation of a layer called "subscale" by some workers. This is a layer which contains silicon dioxide, or perhaps a silicate partly as a cloud of particles in the ferrite and partly on the grain boundaries.

Carbon will not migrate into this subscale at temperatures at which it migrates into what was the ferrite zone. At least one worker has put forward as an explanation the blocking of migratory paths by these inclusions. The idea warrants further attention even though grain boundaries parallel to the surface seem to have perhaps less inclusions than those perpendicular to the surface.

The formation of subscale requires the presence of silicon. If silicon is present, then under given constant conditions the thickness of the scale increases as the square of the time, but in iron differing in silicon content at a given temperature and with a given gas phase the subscale thickness varies inversely as the silicon content, suggesting an exhaustion of the gas activity by reaction with that element.

All white cast irons contain sonims which, at least after ignition to remove carbon, are complexes of $Fe_2O_3$, $Mn_3O_4$, $P_2O_5$ and $SiO_2$. After annealing, the amount of sonims may be nearly tripled without much increase in the concentration therein of $Fe_2O_3$. The concentration of $Mn_3O_4$ largely increases. $P_2O_5$ disappears and the $SiO_2$ decreases in concentration. The total $SiO_2$ per unit weight of iron remains nearly constant but the observations can, in the writer's judgment, best be interpreted as a slight decrease in the total amount of that element. Note that this is true despite the formation of additional $SiO_2$ in the rim. Therefore, apparently $SiO_2$ in the body of the casting may disappear.

Attempts to identify the particular chemical compounds existing in the sonims proved fruitless since x-ray spectra did not agree with any known compounds containing the elements in question.

There is a great increase in interest in America in the so-called "pearlitic" malleable. The name is a misnomer, adopted over this writer's personal protest. These irons contain combined carbon but not necessarily as pearlite.

### Structure Types Desired

There are three quite distinct types of metallography desired for differing purposes. The first consists of temper carbon surrounded, as the petals surround the heart of a daisy, by ferrite crystals, all embedded in a matrix of laminated pearlite. The second consists of temper carbon embedded in a matrix of ferrite throughout which spheroids of cementite are uniformly scattered. The matrix structure is that sometimes designated as "spheroidite." The third structure is that of malleable iron, with a network of finely divided carbides located on the ferrite grain boundaries.

The interest at this point is in the attainment of the desired distribution of constituents. The first structure, the so-called "bull's eye" malleable, is formed in the interval between the stable and metastable $A_1$ point by the direct conversion of austenite into ferrite and temper carbon. The cooling rate must be such that the reaction is complete in the required degree. The structure can be obtained in normal malleable iron with somewhat accelerated cooling but the result is more controllable in the presence of retarding elements, especially manganese.

During the graphitizing process, in this temperature range, ferrite and graphite appear simultaneously. Crystallization is initiated at an existing graphite surface and the ferrite takes an adjacent position and makes the petals of the bull's eye flower.

### Equilibrium Point

If ordinary malleable iron is reheated to a temperature of, say, 850 C for a moderate time, equilibrium appears to be reached with the formation of a saturated solution of carbon in gamma iron. This writer happens to think that this solution may not be identical with austenite of the same carbon concentration.

If the metal is then cooled at the rate which would be supposed to give bull's eye structures, failure is almost certain to occur. A random pattern of ferrite and pearlite results. If, however, the heating at 850 C is greatly prolonged, bull's eyes occur at a suitable cooling rate. The explanation appears to be that whereas white cast iron contains no ferrite when cooling through the critical range begins, a reheated malleable still contains vestiges of ferrite which initiate graphitization

by serving as nuclei for the deposition of alpha iron during the cooling process, giving the resulting iron their own random distribution.

If one wishes the spheroidized matrix, it is quite important to avoid much separation of ferrite during cooling so as to arrive below $A_1$ metastable with a finely laminated or even martensitic structure. A further spheroidizing treatment analogous to that for tool steels is then applied. It may be necessary, in avoiding graphitization during spheroidization, to consider a retardation of the former by suitable alloying.

### Ferrite Appearance

These considerations lead to some comment as to the conditions under which the ferrite first appears by decomposition of martensite. A white cast iron was quenched after attainment of stable equilibrium at 975 C, and then held at various temperatures (below $A_1$ metastable, 770 C) for three hours. At 740 C faint traces of grain boundary ferrite were seen, which became more pronounced in material held at 733 C. At 728 C there was formation of both grain boundary and bull's eye ferrite. At 725 C the formation of bull's eye ferrite predominates, and at 720 C graphitization is sufficiently complete in 8 hours so that only patches of what is probably spheroidized pearlite remain, giving no clue to any ferrite pattern.

Instead of being completely ferritic on holding at any lower temperature, the metal begins to show a general random distribution of large areas of spheroidite when held at 682 C. This is obviously a manifestation of the retardation of graphitization by the low temperature which still permitted spheroidization to proceed.

The temperatures here given do not check too well with the $A_1$ critical range. It is possible that this is due to difference in thermal lag. The manufacture of the pearlitic malleable containing networks of, shall we say, fine pearlite, is an application of a very interesting phenomenon observed many years before a practical application was made.

When an annealed blackheart malleable is heated into the region of the $A_1$ transformation, carbon first dissolves along ferrite grain boundaries. Within a rather narrow temperature range, at each specific temperature, recombination occurs only along a band of definite width. This width is apparently not a function of time after the first brief interval. Plainly the alpha-gamma transformation on heating occurs at a lower temperature for the grain boundary metal than for the body of the ferrite crystal.

One explanation which has been offered is that carbon is more easily taken into the disordered ferrite lattice near the grain boundary than into the regular lattice further in. A hypothesis based on rejections of alloy to ferrite grains would be attractive but is inadequate, for the diffusion of alloying elements, other than carbon, is an extraordinarily slow process and can scarcely be expected to occur at temperatures where ferrite grains form *ab initio*.

### Segregation

That the dendritic segregation of such elements as Si, Mn and P is not overcome by the annealing heat treatment is shown by the fact that cautious etching in alkaline picrate solutions of high boiling point reproduces in a malleable iron the original "as cast" structure. A study of structures, so developed, indicates that to a considerable extent ferrite grain boundaries run, when possible, through areas that were cementitic in the hard iron. Further, the recombination of carbon seems easiest, that is, gamma transformation occurs at the lowest temperatures at boundaries so located.

### Manganese Segregation

It is known that during freezing cementite is enriched in silicon and manganese. The former raises the critical point; the latter lowers it. Apparently, therefore, the segregation of manganese is the dominating factor. Our knowledge is, however, again incomplete for the width of the recarburized bands at the grain boundaries seems less than that of cementite masses, which again brings us back to atomic disorder.

Near the beginning of the discussion of pearlitic malleable the writer risked some criticism by hazarding the opinion that the stable and metastable solid solutions of carbon in iron differ otherwise than in concentrations. The evidence may not be completely convincing. The most important point is that during the process of graphitization the electrical resistance of the material falls, reaching minimum at the point where cementite disappears, and then again rises.

Experiments were made under conditions which did not involve the possible reduction in size of the specimens by oxidation. Also, attempts have been made to photograph the gamma iron x-ray spectra of the stable and metastable solid solutions at high temperatures. The interatomic distance of gamma iron, in which carbon is in stable equilibrium, is practically identical with that of pure iron.

Corresponding interatomic distance in metastable equilibrium is greater than that of pure iron, corresponding to that of austenite of a given carbon concentration. This investigation was not carried on in the writer's laboratory or under his supervision but was executed at one of America's leading technical schools. The investigator, a faculty member of that school, was convinced of the accuracy of his observations and, so far as this writer can judge, his results are entitled to respect.

### Embrittlement Occurrence

The last item requiring attention is the subject of intergranular brittleness. It was long known that much blackheart malleable, when galvanized, became brittle and broke with a white fracture. Explanations were sought in a possible recombination of carbon due to overheating in galvanizing or in hydrogen embrittlement due to pickling. Neither explanation could be justified.

It was finally recognized that embrittlement occurred because of a fairly long sojourn near 475 C and could be prevented by previous quenching from about 650 C or cured by very long holds near 200 C. It was also found that the presence of certain minimum concentrations of silicon and/or phosphorus were necessary to produce the phenomena. Note here an analogy to low temperature impact strength which can be improved by a 650 C quench but only if the same two elements are not present in too large amount.

The current suggestion is that the embrittlement is due to the separation of a grain boundary constituent. A carbide and a nitride have been suggested. The explanation seems weak. No such compounds can be

seen. It is not easy to imagine a cure by low temperature heating and the demonstrable effect of silicon and phosphorus does not enter into the explanation. This is one of the unsolved problems, even though, from an operating point of view, our knowledge suffices. A similar instance where satisfactory operating knowledge exists without proper scientific basis is that the graphitizing rate of white cast iron decreases with the basicity of the refractory in which it is melted.

In preparing the present paper it has seemed wise to adopt a rather strict limitation of metallurgical principles. Obviously the subject could be much expanded in the direction of equilibria in melting furnaces, heat transfer problems and many other engineering fields. These fields, however, are almost never limited to the malleable industry alone and an extension of interest along these lines would produce a paper dealing not with its present subject but with foundry engineering in general.

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## Library Receives Fischer Biography Reporting Early European Metallurgy

"JOHANN CONRAD FISCHER," the biography of an eighteenth century pioneer in the development of steel casting, was recently donated to the A.F.A. Library, National Headquarters, Chicago, by Bruce L. Simpson, president, National Engineering Co., whose company is represented in Switzerland by the organization founded by Fischer—the George Fischer Iron & Steel Works, Schaffenhausen. The 53-page volume, was published last year by a descendant of the German-Swiss metallurgist.

Fischer, who lived from 1773 to 1854, followed family tradition and became a coppersmith. He continued his academic training at night studying Latin, Greek, French, English, mathematics, and physics. The cultural level of the craftsman class was so high that teachers as well as craftsmen were journeymen. Thus they taught their students the general subject matter and also world affairs. They instilled in Fischer an active interest in his community and he served as a member of the town council and later as town president.

When South Germany was invaded by French revolutionary armies Fischer served in the field artillery eventually rising to the rank of Lieutenant Colonel. He lectured to his men on mathematics besides giving them the ordinary instruction.

### Mines Director 50 Years

After the war Fischer was made director of mines in Canton and served for half a century. He believed that those who live now have first right to the gifts of nature, but that these should not be exploited. He directed the men to work only the surface of ore deposits so that the descendants could carry on from there.

Fischer made eight journeys to England not including the apprenticeship year 1794-95 and kept diaries of each trip. These have been very interesting from both the technical and historical points of view for he had the ingenuity to weave everything he saw and heard into a pattern of his own ideas.

At the time of the Exhibition of Arts at Berne in 1804, Fischer was able to record his first successes of experiments in the manufacture of crucible cast steel. He established the first cast steel factory in Schaffhausen using furnaces of his design and manufacture.

In the 1820's the conversion of low-carbon wrought iron into a homogenous melt was brought about. This was after Fischer had discovered ceramic substances capable of withstanding high temperatures and suitable for making molds.

Fischer began to recommend his steel castings to machine manufacturers as a new construction material in 1845. The year is regarded as the first date for the production of steel castings. The steel was cast from bar iron with additional substances and the secret was not revealed until Fischer gave the details at the World Exhibition in London, 1851.

### Developed Nickel Steels

Nickel steel, credited to Fischer was developed after his visit to the Imperial Museum of Natural History in Vienna where there was a display of meteoric iron. Fischer observed the Turk's damascened blades and was convinced they were the result of nickel content of meteoric iron. He began metallurgical experiments in the production of nickel steel alloys.

Fischer continued visits to cast steel works and forges, and often carried small cast ingots or semi-finished products. He would show these wherever he went and sometimes had them made into razor blades which were highly praised. While on these visits, trips to the Patent Office in London would be included either for a study of patent law or for the purpose of securing patents for his inventions.

Fischer's sons completed scientific studies and technical training at their father's works and then went with him to England on several journeys. Thus they were in position to observe the English iron and steel industry before carrying on their work.

The sixth journey to England was in 1845 to study the English railroads. A railroad was to be built from Basle to Constance via Waldshut and Schaffhausen.

In 1848 Fischer was honored for his services in metallurgy at the Swiss Industrial and Handicrafts Exhibition at Berne where his products were awarded the large gold medal and the diploma of honor.

Fischer was asked to contribute to the Great World Exhibition in London, 1851, because his melting-house interested the manufacturers of cast steel. He returned home with many new ideas but without the energy to carry them out. He died December 26, 1854.

# CONTROLLING QUALITY IN CASTINGS PRODUCTION

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THE PURPOSE OF THIS PAPER is to present a new approach to the often distressing problem of maintaining cooperation between the production, metallurgical and inspection personnel, in their combined attempt to keep quality up and costs down.

While the authors' plant makes rough and machined castings on a jobbing basis, the bulk of the castings is used as components of items manufactured in the plant. Only the castings used in the plant's own products will be discussed.

The authors' interpretation of quality control is defined as the necessary inspections or process controls to produce a product to predetermined chemical, physical, dimensional and visual standards at the lowest cost consistent with the standards set. A large contributing factor to low costs is the keeping of rejects to a minimum.

### Quality Control Responsibility

Possibly the most important consideration in setting up a quality control program is determining to whom the quality control personnel shall be responsible. This subject can become controversial. However, the authors made the quality control responsible to the chief engineer, reasoning that the engineering department designs the products and should have some means of assurance that the products they have designed will function as intended when they reach their customers.

Therefore, the man heading up the quality control is assistant chief engineer responsible only to the chief engineer. The quality control man has absolutely no authority over production personnel. Production personnel are held responsible for the quality of the parts produced by their departments and the maintenance of all equipment and processes in the department. It is the quality control's responsibility to supply the production departments with all tests, analyses and other technical information they may need in their operation, such as alloy analyses, complete sand analyses for both foundry and core room, solution analyses for electroplating and the procurement and maintenance of all gages and testing equipment.

Production supervisors are free to make any changes in their manufacturing procedures or processes whenever they feel it will reduce costs. However, the change must be submitted to the quality control man in writing. He will then make the necessary changes in engineering records. This insures against unauthorized changes being made.

On the other hand, quality control does have absolute authority over the quality of work the production departments produce. This authority expresses itself in two ways; first, it is their responsibility to detect and reject all defective castings. These are sorted according to defect or cause of rejection and charged against the department responsible for the rejection, such as foundry, machine shop, polishing, plating or assembly. A casting rejected on the assembly line because of foundry fault is charged to the foundry, not at the value of the original castings, but with all accumulated manufacturing costs up to the time it is scrapped. Scrap reports are turned in every day so an error or carelessness on the part of a production supervisor or his men is immediately observed.

The second and more drastic means the quality control has at its disposal is the authority to stop production on an item in any stage of manufacture, if the rejects become excessive. This usually brings corrective results immediately as almost without exception, it happens on a job that is being expedited.

The quality control man, unless he has tact and is a fair student of psychology, can become disliked, "at least during working hours," instead of being an important spoke in a smooth running wheel of his manufacturing business.

### Control Is Loss Preventive

Setting up a quality control program and getting it into operation may meet with considerable opposition from production personnel. This is especially true after the production man is called to account for excessive scrap or shut down. But if he is open-minded, he will realize that quality control can keep him out of more trouble than it will get him into.

Quality control, if it is to mean *quality* and *control*, must, of necessity, have consideration in the very beginning of a product's design. Quality control at the authors' plant starts before the drawings leave the drafting boards in the engineering department. If a new casting is required, the drawing and design must be approved by three people; the engineer in charge of design, the engineer in charge of quality control and the chief engineer. In this way the quality control man is given the opportunity to question finish allowance or dimensional tolerance he is to maintain

when the casting gets into production. It is equally costly to maintain unnecessarily close tolerances as it is to slight those that should, of necessity, be close. Therefore, it is important to establish limits that are real and practical.

### Standards and Process Controls

After establishing the standards to which the casting is to be manufactured, the inspection or process controls must be set up in every department through which the pieces must pass, from the foundry to the shipping department. To accomplish these inspection and process controls, the quality control man has at his disposal the chemical laboratory, foundry control laboratory, physical testing laboratory, reports on all process data, and departmental inspectors.

Simplicity is the key to a workable plan, which must, in most part, be executed by personnel in the shop who are not required to have technical skill. It is the job of quality control to collect the facts on a casting as it goes through the factory until it is a completed part of an assembly. In this way a history can be had on which to base design, minimizing past trouble in patterns, tooling, finishing and even electroplating. After the drawings have cleared the engineering department, the next step is to check the pattern. No pattern is permitted to be put into production until a rough casting made therefrom has been checked, machined and rechecked, by quality control.

An effort is made to get the molders and melters to follow the same procedure from one hour to the next. It has been found that posting each molder's daily production and scrap on a large and conspicuously located bulletin board in the foundry has injected a spirit of competition among the molders, not only in quantity of production but in the percentage of scrap produced. It also has the effect of forcing the plant to keep pattern and core equipment in top condition as the molder will complain if he thinks his scrap was high because of faulty patterns or cores.

Large dial type recording pyrometers are used for checking pouring temperatures. They also serve the purpose of recording the temperature of each pot of metal poured. It is remarkable how consistently some operators can keep the temperature of the metal they melt, and exasperating how far others can miss it.

Let us retrace the services the quality control performs in and for the foundry. The foundry laboratory takes care of the necessary metal analyses, test bars or other physical tests when required, as well as all phases of sand testing both for the foundry and the core room. The foundry patrol inspector is depended upon for the source of most of the information to run down and stop scrap in the foundry. He checks the foundry scrap daily and posts it on the bulletin board. Every pattern plate and each casting on a plate carries a control number. A record is kept showing the amount of scrap and good castings produced daily from each pattern plate.

### Accurate Records Essential

The records make it possible to check patterns, plate and molder separately. Often, just by switching patterns or plates, it is possible to find whether the molder or the pattern or the individual plate is at fault. Castings found defective anywhere along the line can be traced back to the plate, pattern, molder and floor.

These details aid in clearing up poor production practices. When a man sees his record is not as good as that of another, he will make an effort to do better.

Ideas of individuals, innocently put into practice, will often create an upsetting influence. The patrol inspector makes it his business to fill in his report completely, including such things as changed angle of pour-off racks, venting procedure changed, vents changed on flask, adding water to mold facing or failing to use facing, and many others. Also, the weather and temperature are recorded to help settle melting time and core blow disputes. Cores absorb moisture in damp weather, and exceptionally cold weather will change time required for melting.

The problem in the cleaning room is simple. It involves checking for proper cleaning, over or undergrinding and the removal of core wires, which can cause serious tool breakage in the machine shop.

A similar approach is used in tracing down trouble in the machine shop and on the assembly line. The patrol inspector fills out a daily form recording all tool changes, time down, reason for being down, operator and machine number. At the end of the day, the inspector and the foreman sign the report.

The department scrap is marked and recorded by the man who rejects the castings. These reports from each department are correlated into one daily sheet. The scrap tag is stamped, showing in which department the scrap was produced.

### Daily Production Samples Finished

Machining and polishing are done from current daily stock as much as possible. For instance, if the foundry makes 800 pieces per day, and it is possible to machine or polish only 500 pieces, 300 are put in stock. In this way a large sample of each day's production is obtained. This is only fair to foundry and causes very little extra work. This procedure was instituted after several experiences with running large quantities of rough castings which went into stock and later had to be scrapped because something had gone wrong in the foundry.

On castings that are to be polished and electroplated, it is the practice to put a small sample of each day's foundry run through the polishing operation even if the machining has to be skipped, as the delay between foundry and polishing is too great.

The patrol inspector in the foundry is the key man for he is familiar with all patterns, plates, cores, molders and floor conditions. He is also familiar with rejects and many of their causes. He correlates all the daily reports and records the scrap. The monthly summary sheets are also filled in by him. They give an overall picture of the scrap condition and become an invaluable historical record against which the plant can judge progress or lack of progress.

In conclusion, it is felt that the quality control system outlined in this paper has proved profitable for the company in reducing costs by the reduction of scrap and has practically eliminated the return of material from the field.

# KNOW YOUR COST FACTORS!

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IN A DISCUSSION of cost factors, it is not important that those concerned with costs be convinced that any-one method of cost accounting is the proper one. It is important that they be started thinking in terms of actual costs in their plants.

In figuring cost, four factors must be considered:

1. Cost of materials and supplies.
2. Labor cost.
3. Factory overhead.
4. General overhead, or to be more technical, selling and administrative costs.

It would be regrettable if accounting practice had reached the point that some bookkeepers believe it has, and there was no searching for a quicker and more interpretative way of presenting facts and figures. Using the principles of modern direct methods of cost accounting, the present paper deals with ways and means of making the overhead analysis more interpretive.

Most men in management have had the experience of reviewing an earnings statement. The first thing they notice is the net profit. The first thing they ask is—"Is that all we made? What happened?"

Does the earnings statement tell what happened? It does show this much: 1—the total sales; 2—gross profit and gross profit percentage; 3—it also shows what the selling and administrative expenses were and their percentage to sales.

This information gives clues but not answers. For example, it does not tell:

1. Whether the sales are low on account of physical volume or because of a mixture of volume and price.
2. Whether the gross is low because of lower prices or higher manufacturing costs.
3. To just what extent factory, selling and administrative expenses (overhead) are out of line and what their effect on the net has been in terms of dollars.

### Earnings Statements Should Be Clear-Cut

The uncertainty in the executive's mind, as a result of getting nothing more definite than clues from the earnings statement, leads to muddled interpretations. Muddled interpretations lead to muddled actions. The executive can scarcely be expected to look to the accountant for guidance if this is the best that he can expect. On the other hand, the executive should keep an open mind and, when a sound accounting plan is submitted, accept it.

The purpose of a proper overhead factor analysis is to provide answers to questions and guide the executive's thinking along definite lines so that the actions he should take are obvious, while a conventional earnings statement gives nothing more than clues. Overhead can be broken down into two factors: 1—Factory overhead; 2—general overhead, or selling and administative expenses. These factors will be reviewed briefly.

### Factory Overhead

1. Administrative salaries
2. Clerical salaries
3. Indirect labor
4. Overtime and paid vacations
5. Traveling expenses
6. Supplies
7. Telephone—telegraph
8. Freight—In
9. Freight—Out
10. Rent
11. Light, power and heat
12. Water
13. Maintenance of equipment
14. Maintenance of building
15. Depreciation—machinery
16. Depreciation—auto
17. Insurance
18. Industrial compensation
19. Taxes and social security
20. Taxes—state and county
21. Taxes—other
22. Drayage
23. Spoiled work expense
24. Miscellaneous expense
25. Legal
26. Experimental
27. Guaranteed repairs

### General Overhead

1. Administrative salaries
2. Clerical salaries
3. Indirect labor
4. Overtime
5. Salesmen's salaries
6. Traveling expense
7. Entertainment
8. Supplies
9. Postage
10. Telephone—telegraph
11. Rent
12. Light, power and heat
13. Water
14. Maintenance of equipment (typewriter, calculator, etc.)
15. Depreciation—machinery and equipment
16. Depreciation—auto
17. Insurance
18. Industrial compensation
19. Taxes—unemployment and social security
20. Taxes—state and county
21. Taxes—other
22. Miscellaneous expense
23. Legal
24. Advertising
25. Discount on sales
26. Interest
27. Donations
28. Bad debts
29. Auditing

In order to obtain a basis for computation of these overhead factors, the hypothetical case of an average shop will be considered. This shop employs six men, has a capital investment of $10,000 and the following equipment: planer; bandsaw; 24-in. master disc sander or a small sander; rip saw; spindle sander; cut-off saw; drill press; jointer; lathe—large and small and router; miscellaneous equipment (benches, clamps, etc.).

As an example of the importance of overhead cost factors, suppose that the entire plant capacity was sold for one year on the following basis.

Forty hours per week per man, 50 weeks in the year, with 15 per cent of the total hours on a time and mate-

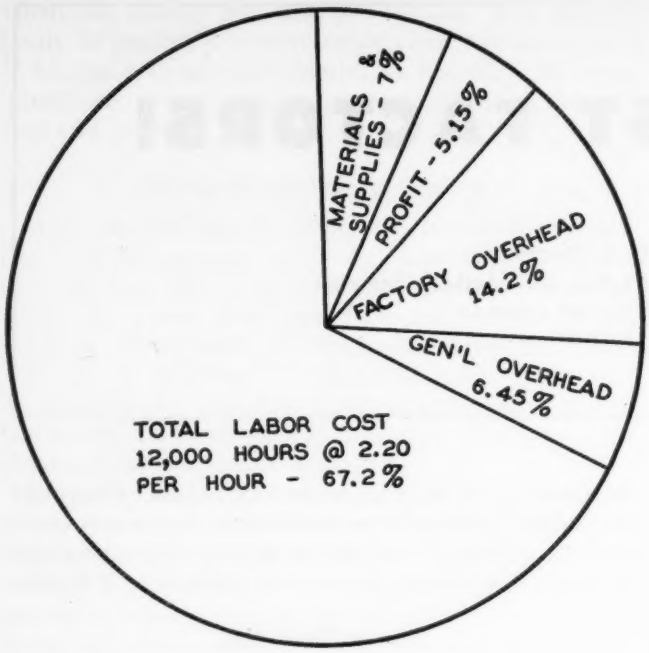



*Chart showing distribution of gross income dollars.*

rial basis, at $4.00 per hour, and the balance of the plant capacity on quoted jobs estimated at $4.00 per hour.

Six men working 40 hours per week will, in theory, turn in 240 productive hours per week. Allowing each man two weeks paid vacation, 50 productive weeks remain, and 240 hours per week multiplied by 50 weeks equals 12,000 hours per year, theoretically. Analyzing this figure, it is found that the lost time is approximately one hour per day per man. The lost time is figured as follows: 10 min lost getting started in the morning; 15 min for rest period in the morning; 5 min early quit at noon; 5 min late start at noon; 10 min rest period in the afternoon; 15 min clean-up at end of day; total, 60 min or 1 hour per day per man.

However, as 15 per cent of the plant capacity is on a time-and-material basis, only 85 per cent of time lost is paid by management. Based on a number of studies, it has been established that hourly paid employees produced at approximately 66 per cent of normal, which is 100 per cent. However, in this case, say that the men are working 90 per cent of normal—then 8 hours less 0.85 hours equals 7.15 hours.

Of the 7.15 hours per day, of which 15 per cent or 1.07 hours is on a time-and-material basis—7.15 hours less 1.07 hours leaves 6.08 hours on estimated jobs.

On the basis of 90 per cent effort during the 6.08 hours, the productive hours are 5.48 on the estimated job. With 5.48 productive hours on estimated job, plus 1.07 productive hours on time-and-material job, the total is 6.55 productive hours in one day, or 6.55 productive hours per man per day: 6.55 hours × 5 days is 32.75 productive hours per man per week; 32.75 hours per week × 6 men is 196.5 productive hours per week; 196.5 hours per week × 50 weeks is 9,825 productive hours per year instead of a theoretical 12,000 hours. Having now established the paid-productive hours, base the calculation on a husband-wife partnership, and see how the partners make out: 9,825 productive hours at $4.00 per hour provides $39,300 gross income.

## Factory Overhead

| Item No. | | Expenditures | Percentage of Gross Income |
|---|---|---|---|
| | Gross Income ($39,300) | | |
| 6. | Material & Supplies | 2,751.00 | 7.00 |
| | Labor Cost @ $2.20 per hr | 26,400.00 | 67.20 |
| 3. | Indirect Labor ($12.00 week) clean shop, office, equipment | 600.00 | 1.53 |
| 4. | Paid Vacations (6 men—2 weeks) | 1,056.00 | 2.69 |
| 5. | Traveling Expense | 250.00 | 0.64 |
| 7. | Telephone & Telegraph | 60.00 | 0.15 |
| 8. | Freight—In | 50.00 | 0.13 |
| 9. | Freight—Out | 75.00 | 0.19 |
| 10. | Rent ($75.00 per month) | 900.00 | 2.29 |
| 11. | Light, Power, Heat | 300.00 | 0.77 |
| 12. | Water (included in rent) | | |
| 13. | Maintenance of Equipment ($6.00 per week) | 300.00 | 0.77 |
| 14. | Maintenance of Building (included in rent) | | |
| 15. | Depreciation—Machinery & Equipment ($10,000—20 yrs, $500.00 yr) | 500.00 | 1.27 |
| 16. | Depreciation on automobile (used for shop business) | 50.00 | 0.13 |
| 17. | Fire Insurance | 45.00 | 0.11 |
| 18. | Industrial Compensation, ½ of 1% | 132.00 | 0.34 |
| 19. | Taxes—Unemployment, 2%—$528.00; Social Security, 1%—$264.00 | 792.00 | 2.00 |
| 20. | Taxes—County and State, 50% true value—$2.97 per $100.00 | 150.00 | 0.38 |
| 21. | Taxes—Other | | |
| 22. | Drayage (Included in Item No. 8) | | |
| 23. | Bad Work Expense | 200.00 | 0.50 |
| 24. | Miscellaneous Expenses | 100.00 | 0.25 |
| 25. | Legal | 25.00 | 0.06 |

Items No. 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, and 25 make up the Factory Overhead. These total $5,585.00, which is 21.20% of the direct labor cost ($26,400). Subtracting these charges from gross income ($39,300) leaves $4,564 to care for General Overhead, or Selling and Administration.

## General Overhead

| Item No. | | Expenditures | Percentage of Gross Income |
|---|---|---|---|
| 6. | Traveling Expenses | 500.00 | 1.27 |
| 7. | Entertainment | 500.00 | 1.27 |
| 8. | Office Supplies | 200.00 | 0.50 |
| 9. | Postage | 100.00 | 0.25 |
| 10. | Telephone & Telegraph | 120.00 | 0.31 |
| 11. | Rent (office) | 300.00 | 0.77 |
| 12. | Light, Power, Heat (See F.O.H. Item No. 11) | | |
| 13. | Water (See F.O.H. Item No. 12) | | |
| 14. | Maintenance of Equipment—Typewriter, Calculator, Check Writer | 60.00 | 0.15 |
| 15. | Depreciation—Office Equipment | 30.00 | 0.08 |
| 16. | Depreciation—Auto | 150.00 | 0.38 |
| 17. | Fire Insurance | 5.00 | 0.01 |
| 18. | Industrial Compensation (see F.O.H. Item No. 28) | | |
| 19. | Taxes—Unemployment and Social Security—(see F.O.H. Item No. 19) | | |
| 20. | Taxes—State and County (see F.O.H. Item No. 20) | | |
| 21. | Taxes—Other | | |
| 22. | Miscellaneous—Association, Magazines, etc. | 100.00 | 0.25 |
| 23. | Legal | 25.00 | 0.06 |
| 24. | Advertising | | |
| 25. | Discount on Sales | | |
| 26. | Interest | | |
| 27. | Donations | 50.00 | 0.13 |
| 28. | Bad Debts | 300.00 | 0.77 |
| 29. | Auditing | 100.00 | 0.25 |

Items No. 6, 7, 8, 9, 10, 11, 14, 15, 16, 17, 22, 23, 27, 28 and 29 make up the General Overhead or Selling and Administrative Costs. These total $2,540.00, which is 9.62% of the direct labor cost ($26,400). Subtracting $2,540 from $4,564, which was the amount remaining after deducting Factory Overhead ($5,585) and direct labor cost ($26,400) from gross income ($39,300) leaves $2,024 as profit for the year.

In other words, the partners have made $2,024, which divided by 2 equals $1,012 each for the year, or $1,012 divided by 2,000 hours is $0.507 per hour each.

A proposed method of figuring a job, which shows the use of the overhead factors derived in the foregoing calculations, has been set up. For comparative purposes, the job is also figured at the $4.00 per hour plant capacity rate used in the detailed cost example.

### Present Method

| | |
|---|---|
| 100 hours @ $4.00 per hour | $ 400.00 |
| Subtract Lost Time, 10.6% | 42.00 |
| | 358.00 |
| Subtract Lost Effort, 10.0% | 36.00 |
| | 322.00 |
| Material | 25.00 |
| | 347.00 |

### Proposed Method

(100 hours plus 10.6% for lost time plus 10.0% for lost effort rating is 121.66 hours)

| | |
|---|---|
| 121.66 hours @ $2.20 per hour | 267.65 |
| Factory Overhead, 21.2% | 56.74 |
| | 324.39 |
| General Overhead, 10.0% | 32.44 |
| | 356.83 |
| Material | 25.00 |
| | 381.83 |
| Profit, 25% | 95.45 |
| | 477.28 |

The $477.28 return with the proposed method represents an increase of 37% over the $347.00 return with the present method. Had the proposed calculation been used in the previous example the gross income ($39,300) would have been 37% greater, or $53,841, and the partners would have realized $14,541 plus $2,024, or $16,565, a profit of 30.7% on the gross.

### Summary

In conclusion, the author wishes to point out that while it was necessary to go through this maze of figures to prove the point, it is not necessary for a plant to have a complex cost system with all the cost centers that have been worked out in this paper. In reality, there are only four figures to be considered:

1. Delay times.
2. The percentage of effort existing in the plant.
3. Proper percentage of factory overhead.
4. Proper percentage of general overhead.

The plant auditor can establish these factors in a short time, so it will not be necessary to use 25 or 30 factors to arrive at the desired result. This discussion is not intended as a lever to increase the cost of the product. It is intended merely to make management cost-conscious, so that none of the overhead factors, which are present in every industry, will be overlooked.

## Process Control Books Describe Recommended Foundry Techniques

FOUNDRY PROCESS CONTROL is described in two books available through A.F.A. Headquarters. Based on the wartime experience of the SAE War Engineering Board and a number of leading foundrymen, the books describe successful foundry techniques for aluminum alloy and ferrous alloy castings.

*Foundry Process Control Procedures (Ferrous)* consists of four sections on ferrous foundry operations. The steel castings section contains general recommendations and procedure, detailed instructions for the various steel foundry processes, the particular processes and specifications at the Ford Motor Co., and a bibliography on steel castings which includes references from 1939-1944.

The section on control procedure for malleable castings includes a brief bibliography and appendices dealing with cupola operation, cupola-air furnace and air-furnace procedure. Foundry process control procedure for gray iron castings gives recommendations for procedure and an appendix on cupola operations.

Castings repair recommendations, covered in a fourth section treats each type of ferrous casting—steel, malleable iron, and automotive gray iron castings—separately.

Foundries making aluminum castings without previous experience during the war made good use of *Process Control of Aluminum Foundry Procedure.* This book was prepared to provide the most acceptable foundry technique and to standardize the procedures among the aluminum foundries filling the vital wartime needs. More than forty leading aluminum metallurgists and foundry technicians cooperated in the preparation of the material.

The fields covered are: aluminum foundry core and molding sands; molding and pouring aluminum sand castings; melting and fluxing of aluminum alloys; cleaning and heat treating; testing and quality control of sand castings; salvaging; foundry procedure and casting control records; and metal and refractory mold castings.

The book contains a bibliography on centrifugal casting. The foundry sand terms are from the A.F.A. HANDBOOK OF FOUNDRY SANDS AND CLAYS.

*Foundry Process Control Procedures (Ferrous)* and *Process Control of Aluminum Foundry Procedure,* both published by SAE in 1945, can be obtained from American Foundrymen's Association, 222 W. Adams St., Chicago 6. Price of each book: $1.00 to members, $2.50 to non-members.

## Discuss Use of Magnesium Castings

ALL MAGNESIUM PERMANENT MOLD CASTINGS are not competitive with aluminum or iron, but the process has many possibilities and magnesium has many advantages, according to J. Colin Smith, American Magnesium Corp., Cleveland, speaking at the fourth annual meeting of the Magnesium Association, March 18 and 19, at the Pennsylvania Hotel, New York.

Lower weight, less finish allowance, closer tolerances, less machining, smoother surface, and uniformity from one lot to another, were cited as factors which might justify use of magnesium permanent mold castings.

# APPRENTICE TRAINING OR SHORT TERM TRAINING?

**J. G. Goldie**
**General Superintendent**
**M.B.M. Foundry, Inc.**
**Cleveland**

APPRENTICE TRAINING was discussed at the first A.F.A. meeting in Philadelphia, in 1896, and the writer has a copy of the report given by the Apprentice Training Committee at the 2nd Annual meeting in Detroit, in 1897. Incidentally, the Apprentice Training Committee is the oldest functioning committee of the A.F.A. The problems which confronted the foundrymen and this committee of 50 years ago are fundamentally the same as those which confront them today. The problems now, as then, are:

1. What are the foundries doing to maintain a constant source of labor supply?

2. By what methods can the foundries maintain the efficiency of the men in the individual plants?

The answer to each of these questions has changed but little, with one exception—statistics show that the greatest influx of immigrants into this country took place between 1890 and 1923. The majority of these people were young men who brought with them a skill and a willingness to work hard and learn the methods of a new country. In that period the foundries received a goodly share of this trained labor supply, and a good number of our foundries are still manned by these men—only they are no longer young. This was perhaps the oustanding source of supply and was the first method of keeping the foundries well stocked with experienced mechanics. This method has been greatly curtailed due to immigration laws, so this source of labor is a thing of the past. The second answer to the problems was, and is, apprentice training.

### Too Few Apprentice Training Programs

A number of foundries (but *too few*) established and still maintain apprentice programs, and to these foundries the industry owes gratitude for the far-sightedness which provided it with the outstanding men of today. Many are the foundries whose success today is due to the fact that they are managed by men who graduated from these apprentice programs.

A group of other foundries had the third answer to the problem, namely, a hit-or-miss type of training, no actual training program—a "come in and try, and if you can make good, OK"—no supervision, no incentive, nothing planned, no teaching how or why but lots of telling when. The result of this was, and is, disastrous. Many young men started in the foundry under these conditions but few have remained.

NOTE: This paper was presented at the 1st Ohio Regional Foundry Conference, in Cleveland, March 11-12, 1948.

The fourth, and perhaps the worst answer to the problem, is the one employed by a number of foundries. It is the method of enticing young men from other foundries, or depending on the driftwood which floats about the country. Many of these young men who were enticed and a great many of the drifters have been good molders, but it is questionable whether they added much to the development of good personnel within the foundry industry.

### Origin of Short Term Training

A fifth answer, or part answer, to the problem came in the early 1920's and gave its greatest help during the late war. It was first known as the National Defense Training Program, then Emergency Training Program, then the War Training Program, and out of this has come what is now called Short Term Training. No one will argue but that these emergency programs did a great deal to keep the foundries going at the high speed that was demanded prior to and during the war. These programs also brought out the fact that in some foundries short term training is all that is required for the majority of the workers. A great many of these men have remained in the industry, so perhaps the emergency programs are to be thanked for bringing a lot of men into the foundries who otherwise would not have been available.

From the five answers to the foundry personnel problem is developed the subject under discussion, namely, apprenticeship, short term training, or both. In the author's opinion, both have their advantages, but where they should be applied and how much of each depends upon a number of conditions: 1. type of foundry; 2. size of foundry; 3. degree of skills required; 4. extent of training facilities.

### Apprenticeship Is Basic

Every foundry, regardless of type or size, should have an apprentice program, whether it be for one apprentice a year or one hundred, because apprenticeship is the base or foundation from which the foundry builds. Most foundrymen agree that the idea of apprenticeship is sound, the principle good, but the majority keep putting it off and off while still demanding skilled and semi-skilled help for the foundries.

This brings up the question of the type of apprentice program which should be put into effect in a foundry. Space does not permit going into detail on all of the different types of apprentice programs, but full infor-

mation may be obtained from the A.F.A. National Office and the Federal Committee on Apprenticeship. Many plans have been published, many articles written, and much free help is available for setting up apprentice programs. Apprentices do not walk into a plant—they must be invited. Apprenticeship is largely up to the employer. It is he who must decide if his business will need a continuing supply of skilled men in the years ahead.

### How Long Should Apprenticeship Be?

During the past few years many articles have been written, pro and con, on the length of apprenticeship. In the author's opinion the length of foundry apprenticeship is a matter of how much the employers wish their apprentices to learn. If it is desired that the apprentice learn a part of the trade, or part of the operations in the foundry, then the apprenticeship can be set up to cover that particular part, but at the termination of that one part the apprentice should not be classified as a finished mechanic.

In general, standards or length of apprenticeship should be set up to cover the different branches of the trade or types of molding and coremaking. To set up a hard and fast set of standards is a difficult job, but an attempt will be made to give what the author believes to be the types and length of training which will produce results in almost any foundry.

Four classifications will cover all types of apprenticeship: 1. Apprenticeship in the foundry trade; 2. apprentice molder; 3. apprentice machine molder; 4. apprentice coremaker. Under each of these headings the time and jobs should be set up much in the following fashion, although this can be changed to suit types of foundries and types of work.

### Four Apprenticeship Classifications

1. *Apprenticeship in the Foundry Trade.*
   Pre-apprenticeship requirement—3 months as foundry helper. Bench molding (1 year and 3 months); flat backs; flat backs with green sand cores; flat backs with dry sand cores; flat backs with green and dry cores; irregular parting jobs; split patterns; gated work; match making—sand, clay, plaster, etc. Floor molding (2 years and 3 months); side floor work (green sand); main floor (green sand, dry sand, loam).
   Machine molding (3 months); squeezer jolt; roll-over, etc.
   Coremaking (3 months): bench and floor.
   Post-apprenticeship: Cupola practice—3 months; cleaning and inspection—3 months; sand testing, metal analysis, time study—3 months. Thus the apprentice in the foundry trade would serve 5 years.
2. *Apprentice Molder* (bench, floor, and machine).
   Pre-apprenticeship requirement—3 months as molder's helper. Bench molding (1 year and 3 months); floor molding (2 years and 3 months); machine molding (6 months). If at the end of 4 years and 3 months the apprentice molder wishes to continue, he could take the required extra training which would put him in a class with No. 1.
3. *Machine Molder Apprentice.*
   Pre-apprenticeship requirement—3 months as helper. Plain squeeze (3 months); jolt squeeze (4 months); combination jolt squeeze and roll-over (4 months); cope and drag (4 months); sand slinger (6 months). This 2-year course is the only one in which the apprentice would receive credit for pre-apprentice work.
4. *Apprentice Coremaker.*
   Pre-apprenticeship requirement—3 months as helper. Pasting-filing stock cores (3 months); bench work (1 year); floor work (1 year); core blower (3 months); core machine (3 months); sand mixing, time study (3 months). Total time for the course is 3 years and 3 months.

Standards for Apprenticeship would read:

*Apprenticeship Foundryman:* Pre-apprenticeship—3 months; apprenticeship—4 years; post-apprenticeship—9 months.

*Apprentice Molder:* Pre-apprenticeship—3 months; apprenticeship—4 years.

*Apprentice Core-Maker:* Pre-apprenticeship — 3 months; apprenticeship—3 years.

*Apprentice Machine Molder:* Pre-apprenticeship—3 months; apprenticeship—1 year, 9 months.

### Should Yield Results in Short Time

This is a long-range program, but if started now and kept going, even in a small way, it will show definite results in a short time.

Short term training can be worked into this program or can be worked separately, but it must be remembered that short term training is usually job training—training for one specific job, doing the same thing day in, day out. It has its place in the foundry and many young men are content to follow it, becoming good workers and good employees. But it has no place in the jobbing foundries, and certainly the young man who is looking for a trade and advancement has no place in his mind for this type of training.

In conclusion the answer to the question "Apprenticeship, short term training, or both?" may be summarized as: Build the foundation with apprenticeship; add the minimum of short term training; use both to advantage of the foundry and the men.

## Presenteeism – A Positive Approach To An Industry Personnel Problem

PRESENTEEISM is the word coined by the Belle City Malleable Iron Co. and the Racine Steel Castings Co., Racine, Wis., to replace the overworked absenteeism in widespread use during and since the war.

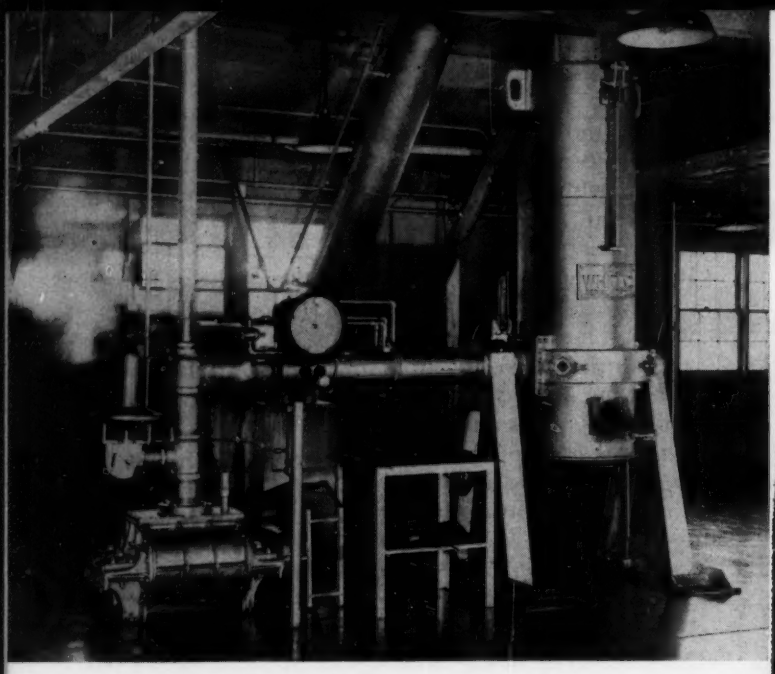
In praising its employees for perfect attendance records, in place of the usual practice of condemning its absentees, the companies *Bel Rac News* says:

"Although a punch clock is an inanimate object and cannot actually call the roll of employees every working day, it does keep a record of your attendance, just as your old schoolmarm used to do. It beams when you answer "present" and we beam, too, when we look at the list of Belle City employees who were on the job every working day during 1947.

"Most employees are here most of the time with only infrequent excusable absences. It is the few habitual absentees who damage our presentee record.

"From a practical standpoint, your absences cost you money. Each workday missed means a deduction from your check—be on the job during 1948."

# NEW METAL CAST AT UNIVERSITY



*(Above) The cupola, mounted on hollow trunnions, can be tilted to a horizontal position for easy patching. (Right) Cleaning area includes sand and shot blast equipment, tumbling and grinding facilities.*

**R. W. Heine**
**Foundry Instructor**
**University of Wisconsin**

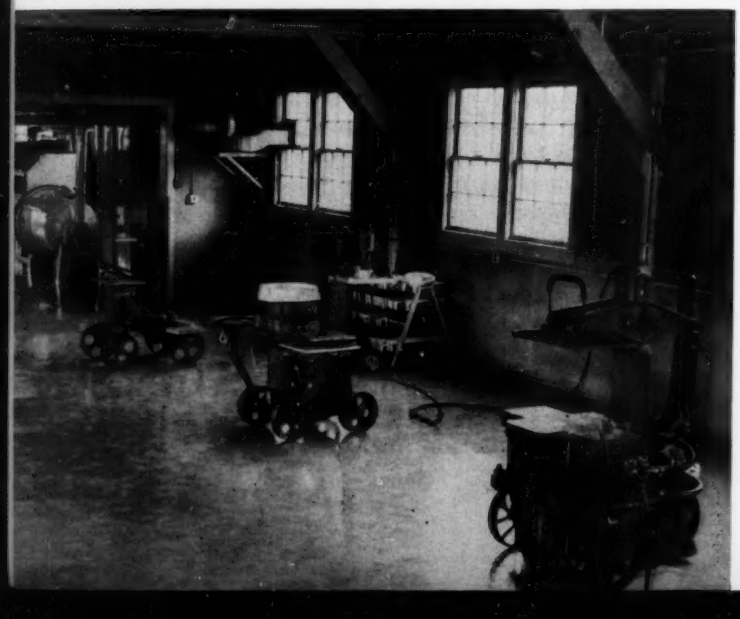
ENCOURAGED BY MEN OF VISION in the foundry industry and the University of Wisconsin, and by programs of the American Foundrymen's Association and Foundry Educational Foundation, the department of mining and metallurgy has extended its instructional facilities in the metal casting field. A new foundry has been established and equipped for providing fundamental instruction in the engineering and science of foundry practice. The new metal casting laboratory, after three months' use, was shown to the public at an open house held May 25. The Wisconsin Chapter of A.F.A. and the state's foundrymen, as well as the general public, were invited to view the new foundry laboratory. Representatives of the A.F.A. National Office and the industry were present to inspect the university's extended service in this field of engineering.

Considerable attention in the development of the new laboratory has been given to correlating plant facilities with the academic course work in foundry and related subjects taught at the University. Equipment, plant layout, and materials have been selected with the intention of teaching metal casting to engineering students in a way that emphasizes the process as one of the basic methods of putting metals into useful shapes. Such a teaching approach involves considerations of the technical and scientific fundamentals of the foundry process, its role in relation to other engineering processes, and its significance economically and socially. The new foundry laboratory enables the student to see the application of scientific and engineering fundamentals in the methods, materials, and equipment employed by foundrymen.

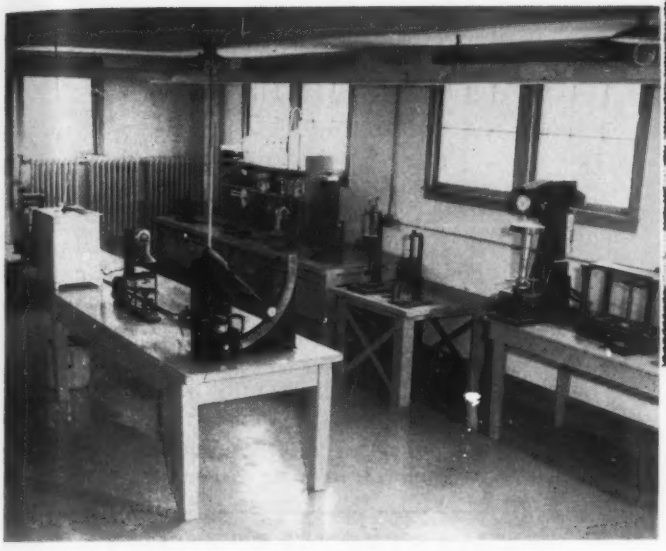
The foundry at the University of Wisconsin occupies a single story U-shaped building having 6,460 sq ft of floor area. The building houses a classroom, office, and the metal casting laboratory proper. Work areas in the laboratory which have been laid out to show the fundamental operations carried on in a foundry are: (1) sand conditioning, (2) molding, (3) coremaking, (4) melting and pouring, (5) shakeout, cleaning and inspection, (6) sand laboratory, (7) pattern storage, (8) general storage of materials and tools, (9) metallurgical laboratory (in adjacent metallurgy department building).

The general molding area provides space for bench molding and machine molding of small and medium castings. Sufficient instruction in hand molding is provided so that the student will realize by direct contact some of the problems which are solved by machine molding. Molding machines presently available for student use consist of a squeezer, jolt-squeezer, and a cope and drag pair of the jolt-squeeze stripper pin lift

*Students learn the operation and advantages of molding machines in the machine and floor molding area.*



# ING LABORATORY OF WISCONSIN



*(Above) Melting area in the foreground. Bench and machine molding areas in the background provide ample space for classes of about 15 students. (Left) The sand laboratory is adjacent to the sand preparation areas for convenience in making control tests.*

type and jolt-squeeze rockover type. Floor molding instruction is given on a demonstration basis. Sand conditioning occurs immediately adjacent to the molding area. Ferrous and non-ferrous natural sands are used chiefly but synthetic sands are mixed for instructional purposes.

The cupola is lined to 18 in. inside diameter and equipped with an air-weight control. A unique feature of this installation is the method of handling the cupola gases. The stack is equipped with a downcomer connected to an exhaust fan. The gases are cooled by a water spray in the downcomer and exhausted through the side of the building at window level. A tilting pot-furnace is used for non-ferrous melting. A 250-lb direct arc furnace for steel melting, and high-frequency induction melting units are yet to be installed though presently available for use.

Core sands are stored within the building and adjacent to the core room. While cores are presently made by hand, a small size commercial core blower is expected to be installed.

The sand laboratory is readily accessible to both the molding and core sand conditioning areas. This laboratory has been equipped for both the routine sand control tests and for sand research work.

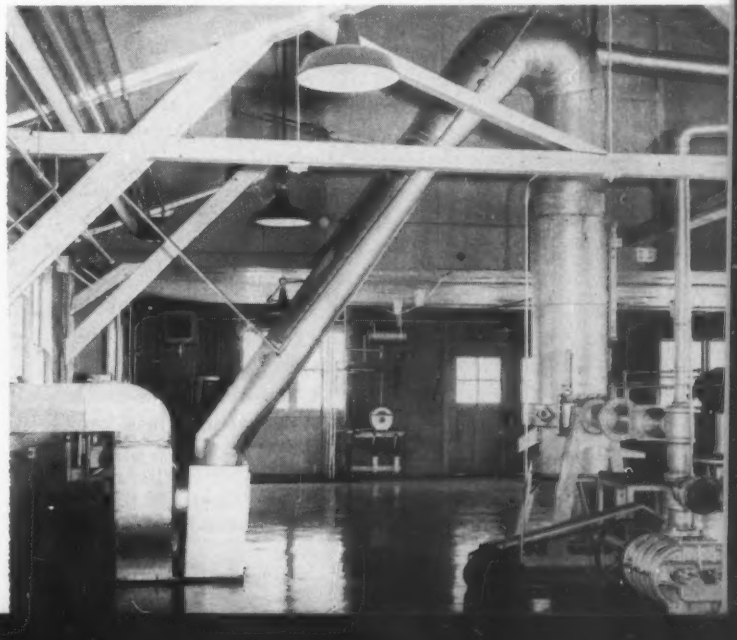
The cleaning area demonstrates some of the types of cleaning equipment used commercially and is, of course, used for cleaning the castings produced by the students. The cleaning equipment includes a sand blast cabinet, a tumbling mill, and a wheelabrator swing table useful for shot peening studies as well as cleaning of castings. There are the usual hand tools and grinding equipment together with an exhaust type ventilating system.

Foundry equipment to be installed later includes a centrifugal casting machine, roll conveyors, a mechanical shakeout, and a monorail for mechanized pouring.

For those students at the University of Wisconsin who are to become more directly concerned with metal castings, the laboratory and course work in foundry is of special interest because of Wisconsin's position among the ten leading foundry states of the United States and the close proximity of five other of the leading ten. As one of the six universities cooperating with the Foundry Educational Foundation, Wisconsin occupies a very favorable position for introducing young engineers to careers in the foundry industry.

In addition to the teaching purposes of the new laboratory, it serves as the workshop for the research of faculty and students. The variety of equipment available is especially suited to investigations in foundry materials and processes and to the metallurgy of cast metals. Such work will be considerably encouraged

*Exhaust gases from the cupola are water cooled as they pass through the downcomer to the exhaust fan.*



*The Core room provides space for making bench cores, sand mixing, and will house coreblowing equipment.*

by the recently reactivated University of Wisconsin engineering experiment station.

The development of the metal casting laboratory has gone forward under the direction of Professor G. J. Barker, chairman, and Prof. P. C. Rosenthal of the department of mining and metallurgy. Dean M. O. Withey of the engineering college has provided the administrative encouragement so essential to a program of this type. To the men of the foundry industry a proper acknowledgment is due for their part in providing a field of opportunity for young engineers. The Wisconsin Chapter of A.F.A., the work of its educational committee, the Foundry Educational Foundation, and the A.F.A. National Office have been the instruments of men in the industry who have so greatly assisted the development of the project.

Metallurgical, chemical, and mechanical testing laboratory facilities are readily accessible in the adjacent building of the department of mining and metallurgy. For casting soundness inspection, a 120 kv radiographic machine is available. X-ray diffraction and spectrographic equipment of the latest types may be operated by qualified students. The inter-relation of the many types of equipment is well illustrated by their use throughout the courses offered.

### The "Clean" Foundry

Prime consideration in the development of the new laboratory was given to the thought that the foundry should be a clean and attractive place for work. One value of this is the development of habits of cleanliness and good housekeeping. Painted floors and equipment serve to emphasize that a clean foundry is possible and the results have proved it desirable.

Elimination of the sand heap and the drop around the cupola helps considerably. The cupola bottom is dropped into a gondola that is immediately carted outdoors and wet down, thus removing the smoldering mass from the laboratory. A movable pouring platform was devised to keep metal drippings off the floor. A vacuum cleaner removes dust from the overhead, window ledges and floor. A ten-minute housekeeping period at the end of each laboratory class keeps the metal casting laboratory clean.

After a semester of operation under these conditions it is evident that the small effort expended for good housekeeping has developed greater interest among the students in foundry work.

### Laboratory Aids Two Departments

The metal casting laboratory serves two departments of instruction in the engineering college of the University of Wisconsin. The department of mining and metallurgy provides instruction in foundry for all mechanical engineering students. In these courses, the operating and engineering phases of the industry are emphasized. For the metallurgical engineering students, concentration is on the technical and metallurgical phases of foundry work. Students may take either of the courses to suit their purposes and, furthermore, students in any of the branches of the engineering school may elect the courses. It is usual to have chemical, electrical, civil, and agricultural engineers in the classes. For the most part, these students have had little prior contact with the foundry and for many the course work is their only direct contact. The metal castings laboratory gives these men an insight into the foundry industry and its role in engineering fields.

## CHAPTER ELECTIONS

### Timberline Chapter

*(Elections Held April 13)*

*Chairman*—J. L. Higson, Western Foundry.

*Vice-Chairman*—Shelby C. Cooke, Sr., U. S. Foundries, Inc.

*Secretary*—John W. Horner, Jr., Slack-Horner Brass Mfg. Co.

*Treasurer* — Alvin O. Gruenwald, Manufacturers' Foundry Corp.

*Directors—Terms Expire 1950*

E. B. McPherson, McPherson Corp.
Pearson M. Payne, Rotary Steel Castings Co.
C. C. Penney, C. S. Card Iron Works Co.
Edward B. Zabriskie, Magnus Metals Division, National Lead Co.

*Directors—Terms Expire 1951*

William E. Norris, American Manganese Steel Division.
A. H. Patten, Patten Engineering Co.
Arthur L. Schneider, Western Bronze & Brass Foundry.
James W. Silver, Ogden Iron Works Co.

### Metropolitan Chapter

*(Election held April 5)*

*Chairman*—John A. Bukowski, Worthington Pump & Machinery Co.

*Vice-Chairman*—Thomas J. Wood, American Brake Shoe Co.

*Secretary*—J. F. Bauer, Hickman, Williams & Co.

*Treasurer*—Dan Polderman, Jr., Whiting Corp.

*Directors—Terms Expire 1950*

Frank B. Eliason, Pennsylvania Foundry Supply & Sand Co.
Ernest R. Miller, Bethlehem Steel Corp.
John Van Haver, Worthington Pump & Machinery Co.
Robert C. Pitz, Pitz Foundry.
Aubrey E. Winstead, The Moore Brothers Co.

# Chapter Officers FAA and Directors

**Marvin Williams**
Hughes Tool Co.
Houston, Tex.
**Chairman**
**Texas Chapter**

**Fitz Coghlin, Jr.**
Albion Malleable Iron Co.
Albion, Mich.
**Secretary-Treasurer**
**Central Michigan Chapter**

**Otto Frank**
Muskegon Piston Ring Co.
Sparta, Mich.
**Director**
**Western Michigan Chapter**

**F. P. Volgstadt**
Griswold Mfg. Co.
Erie, Pa.
**Secretary-Treasurer**
**N. W. Pennsylvania Chapter**

**E. H. Bankhard**
General Motors Corp.
Flint, Mich.
**Director**
**Saginaw Valley Chapter**

**R. H. Williams**
Canadian Westinghouse Co., Ltd.
Hamilton, Ontario
**Director**
**Ontario Chapter**

**B. E. Beldin**
Whitehead Brothers
New York
**Director**
**Metropolitan Chapter**

**Victor Rowell**
Velsicol Corp.
Chicago, Ill.
**Secretary**
**Chicago Chapter**

**D. E. Stine**
La Consolidada, S.A.
Mexico City
**Director**
**Mexico City Chapter**

**R. C. Wood**
Minneapolis Electric & Steel
Castings Co.
**Director**
**Twin City Chapter**

**C. L. Dahlquist**
Greenlee Bros. & Co.
Rockford, Ill.
**Technical Secretary**
**N. Ill.-S. Wis. Chapter**

**E. G. Fahlman**
The Permold Co.
Medina, Ohio
**Director**
**Northeastern Ohio Chapter**

# New AFA MEMBERS

**Period April 15 — May 15: Two membership conversions and 208 new members mark this period during which 40 chapters showed gains. Leaders were: Detroit, 23; Philadelphia, 15; Chicago, 11; Metropolitan, 11.**

## CONVERSIONS

### Company to Sustaining

*Glamorgan Pipe & Foundry Co., Lynchburg, Va.*—J. C. Dabney, Jr., (Chesapeake Chapter).

### Personal to Company

*Rich Mfg. Company, Portland, Oregon*—E. J. Hyche, V.P. (Oregon Chapter).

## NEW COMPANY MEMBERS

*American Light Alloys, Inc., Little Falls, N.J.*—William Wilson, Jr., President, (Metropolitan Chapter).

*General Grinding Wheel Corp., Philadelphia, Pa.*—W. G. Pinkstone, Vice-President, (Philadelphia Chapter).

*Johnstone Foundries, Inc., Grove City, Pa.*—George Johnstone, Jr., President & Gen. Mgr. (Northwestern Pennsylvania Chapter).

*Ohio Injector Co. (Steel Foundry), Canton, Ohio*—Bert Ulehake, Mgr. (Canton District Chapter).

*Precision Castings Co., Syracuse, N.Y.*—A. E. Martin, Met. (Central New York Chapter).

*Tredegar Company, Richmond, Va.*—I. A. Kinsey (Non-Chapter).

## BIRMINGHAM DISTRICT CHAPTER

Irwin K. Clisby, Pres., I. K. Clisby & Associates, Birmingham.
W. D. Cunningham, Repr., Master Pneumatic Tool Co., Inc., Orwell, Ohio.
Aubrey Garrison, Met., Continental Gin Co., Birmingham.
James C. Pope, V.P., Southeastern Castings Co., Anniston, Ala.

## BRITISH COLUMBIA CHAPTER

E. J. Jefferys, Molder, Terminal City Iron Works, Ltd., Vancouver, B.C.

## CANTON DISTRICT CHAPTER

***Ohio Injector Co. (Steel Foundry) Canton. (Bert Ulehake, Mgr.).**
Robert Leonard Sell, Analyst & Supv. Cost Accounting Dept., The Colonial Foundry Co., Louisville, Ohio.

## CENTRAL ILLINOIS CHAPTER

Ralph Beebe, Fdry. Supt., International Harvester Co., Canton, Ill.
W. C. Bliesener, Works Met., International Harvester Co., Canton, Ill.
O. E. Bond, Pres., Bond Foundry Corp., Decatur, Ill.
R. V. Paul, Foundry Cost Acct., International Harvester Co., Canton, Ill.

## CENTRAL INDIANA CHAPTER

E. E. Alpers, Met. Engr., General Motors Corp., Central Foundry Div., Danville, Ill.
C. L. Davis, Abras. Engr., General Grinding Wheel Corp., Philadelphia, Pa.
S. G. Disque, Owner, Disque Steel Products Co., Indianapolis, Ind.
L. C. Flagin, Fdry. Supt., Roots-Connersville Blower Corp., Connersville, Ind.
B. J. Lavelle, Jr., Fact. Mgr., Laville Gray Iron Foundry Corp., Anderson, Ind.
Ralph L. Miller, Freeman Supply Co., Toledo, Ohio.
R. C. Risch, Fdry. Frm., Roots-Connersville Blower Corp., Connersville, Ind.
Robert Spurgin III, Fdry. Supt., Swayne, Robinson & Co., Richmond, Ind.

## CENTRAL MICHIGAN CHAPTER

K. J. Hamaker, Owner, Hamaker Pattern Shop, Marshall, Mich.
H. D. Westafer, Supt., Riverside Foundry & Galvanizing Co., Kalamazoo, Mich.

## CENTRAL NEW YORK CHAPTER

***Precision Castings Co., Syracuse, N.Y. (A. E. Martin, Met.).**
H. D. Ferguson, Mgr. Fdry. Dept., Cramer Refractories Co., Inc., Liverpool, N.Y.
J. P. Penrod, Dist. Sales & Service Engr., Pangborn Corp., Syracuse, N.Y.
R. H. Wright, Sales Repr., The United States Graphite Co., Saginaw, Mich.

## CENTRAL OHIO CHAPTER

Wm. Davis, Fdry. Supt., Lennox Furnace Co., Columbus, Ohio.
W. P. Hooper, Supt., Furnace Foundry Co., Jackson, Ohio.
H. J. Skidmore, Frm., Furnace Foundry Co., Jackson, Ohio.

## CHESAPEAKE CHAPTER

G. F. Pettinos, Jr., V.P., George F. Pettinos, Inc., Philadelphia.
H. R. Williams, Salesman, George F. Pettinos, Inc., Philadelphia.

## CHICAGO CHAPTER

J. A. Brislane, Abr. Engr., General Grinding Wheel Corp., Philadelphia.
A. H. Colwell, Jr., Chemist, Pittsburgh Metals Purifying Co., Pittsburgh, Pa.
Mike Lauriente, Met., McCormick Works, International Harvester Co., Chicago.
J. R. Lowry, Fdry. Sales, Steel Sales Corp., Chicago.
Cornelius McGlone, Prod. Application Engr., Whiting Corp., Harvey, Ill.
J. P. Moniger, Sales Engr., Steel Sales Corp., Chicago.
Robert Muhleman, Prod. Application Engr., Whiting Corp., Harvey, Ill.
J. C. Peirce, Engr., Pangborn Corp., Chicago.
R. P. Rozycki, Appr., Ace Foundry Co., Chicago.
M. W. Senew, Cons. Met., Pennies Industrial X-Ray Co., Chicago.
R. H. Zimmerman, Student, International Harvester Co., Tractor Works, Chicago.

## CINCINNATI DISTRICT CHAPTER

J. D. Altstetter, Student, University of Cincinnati, Lima, Ohio.
P. Breeden III, Sales Engr., Penola, Inc., Chicago.
R. R. Pickering, Frm. Steel Fdry., Hobart Mfg. Co., Troy, Ohio.
N. F. Ritchey, Tech. Serv. Engr., Reynolds Metals Co., Aluminum Sales Div., Louisville, Ky.
O. G. Saunders, Met., The Hobart Mfg. Co., Troy, Ohio.
D. O. Shoup, Frm., The Hobart Mfg. Co., Troy, Ohio.
G. R. Stockmeier, Fdry. Engr., The Hobart Mfg. Co., Troy, Ohio.

## DETROIT CHAPTER

R. E. Arthur, Abr. Engr., General Grinding Wheel Corp., Philadelphia.
H. F. Ayres, Mech. Supv. Fdry., Packard Motor Car Co., Detroit.
A. F. Bade, Plant Engr., Forge & Fdry. Div., Packard Motor Car Co., Detroit.
J. W. Beavis, Gen. Frm., Packard Motor Car Co., Detroit.
F. W. Boehmer, Fdry. Trainee, The Wilson Foundry & Machine Co., Pontiac, Mich.
B. W. Bogert, Supt., Dostal Per-Mold Foundry Co., Pontiac, Mich.
W. V. Cunningham, Supv., Wilson Foundry & Machine Co., Pontiac, Mich.
Elio DeCapite, Fdry. Supt., City Pattern, Foundry & Machine Co., Detroit.
James Garrett, Asst. Supt. Fdry., Ford Motor Co., Dearborn, Mich.
W. E. Goudey, Supt., Ford Motor Co., Dearborn, Mich.
Fredrick Grolla, Frm. Inspection Fdry., General Motors Corp., Cadillac Motor Car Div., Detroit.
T. C. Hadden, Salesman, A. P. Green Fire Brick Co., Mexico, Mo.
William Henry, Frm., Packard Motor Car Co., Detroit.
C. J. Hoffman, Student, General Motors Institute, Cadillac Motor Car Div., Detroit.
C. J. Kolenda, Frm., Packard Motor Car Co., Detroit.
Len Kutchins,, Abr. Engr., General Grinding Wheel Corp., Philadelphia.
Granville Leech, Patt. Shop Frm., Packard Motor Car Co., Detroit.
D. H. Page, Res. Mgr., K-F Dowagiac Foundry Div., K-F Detroit Eng. Div., Dowagiac, Mich.
H. X. Reece, Abr. Engr., General Grinding Wheel Co., Philadelphia.
R. L. Reed, Sales Repr., Electrometallurgical Sales Corp., Detroit.
Carl Rigg, Purch. Agent, Schwarz Foundry Co., Detroit.
A. C. Schroeder, Jr., Foundry Trainee, Wilson Foundry & Machine Co., Pontiac, Mich.
A. R. Soltis, Reg. Mgr., General Grinding Wheel Corp., Philadelphia.

## E. CANADA & NEWFOUNDLAND CHAPTER

Andre Bonthillier, Student, Montreal Technical School, Montreal, Que.
Nicholas Damato, Melter, Crane Ltd., Montreal, Que.
Roger Hebert, Molder, Crane Ltd., Montreal, Que.
Louis Hillinger, Bench Molder, Crane Ltd., Montreal, Que.

## EASTERN NEW YORK CHAPTER

N. B. Akitt, Mech. Engr., Adirondack Foundries & Steel Inc., Watervliet, N.Y.
T. J. Eagan, Salesman, Samuel Greenfield Co. Inc., Buffalo, N.Y.
D. G. Wheeler, Wheeler Bros. Brass Founders, Inc., Troy, N.Y.

## METROPOLITAN CHAPTER

***American Light Alloys, Inc., Little Falls, N.J. (William Wilson, Jr., Pres.).**
D. F. Cameron, Librarian, Rutgers University Library, New Brunswick, N.J.
Vincent Carl, New York Sand & Facing Co., Brooklyn, N.Y.
S. W. Dickey, American Brake Shoe Co., Mahwah, N.J.
Mario Dionisio, Supv., Cooper Alloy Foundry Co., Hillside, N.J.

* Company Members

Stanley Einhorn, Appr. & Stud., Parkway Foundry & Machine Corp., Brooklyn, N.Y.
P. E. Malloy, Fdry. Supt., Scovill Mfg. Co., Waterville Div., Waterville, Conn.
J. M. Planten, Res. Engr., Lester B. Knight & Associates, Chicago.
A. F. Quern, Fdry. Engr., Whitehead Metal Products Co., Inc., New York.
Ben Spindler, Partner, Spindler Brothers, Kenilworth, N.J.
Stanley Trusewicz, Frm., American Brake Shoe Co., Mahwah, N.J.

## MEXICO CITY CHAPTER

Urbano Lopez Ayala, Met. Engr., The Teziutlan Copper Co., Aire Libre, Pue.
W. F. Bollinger, General Mgr., National Iron & Steel Works, S. A. Mexico, D.F.

## NORTHEASTERN OHIO CHAPTER

M. E. Dawson, Sales Engr., C. O. Bartlett & Snow Co., Cleveland.
W. A. Mazan, Engr., Westinghouse Electric Corp., Cleveland.
H. C. Miller, Jr., Student, Case Institute of Technology, Cleveland.
J. E. Orr, Salesman, George F. Pettinos, Inc., Philadelphia.
J. N. Schweikert, Gen. Mgr., Lake City Malleable, Inc., Ashtabula, Ohio.
J. A. Sharritts, Fdry. Supt., Westinghouse Electric Co., Cleveland

## NORTHERN CALIFORNIA CHAPTER

Jack W. R. Lemery, Mech. Engr., General Metals Corp., Oakland, Calif.

## NO. ILLINOIS & SO. WISCONSIN CHAPTER

J. E. Carbery, Asst. Frm., Greenlee Bros. & Co., Rockford, Ill.
R. N. Chalman, Supv., J. I. Case Co., Rockford, Ill.

## NORTHWESTERN PENNSYLVANIA CHAPTER

*Johnstone Foundries Inc., Grove City, Pa. (George Johnstone, Jr., Pres. & Gen. Mgr.).
T. H. Brown, Johnstone Foundries Inc., Grove City, Pa.
H. S. Chambers, Prod. Mgr., Johnstone Foundries Inc., Grove City, Pa.
P. W. Christie, Met., Johnstone Foundries Inc., Grove City, Pa.
Richard Ericsson, Appr., General Electric Co., Erie, Pa.
Alex Morrison, Gen. Frm., Johnstone Foundries Inc., Grove City, Pa.

## ONTARIO CHAPTER

Herbert Fairfield, Met., Wm. Kennedy & Sons, Owen Sound, Ont.
L. L. Johnson, Mold. Frm., Cockshutt Plow Co. Ltd., Brantford, Ont.
E. Solman, Cup. Frm., Cockshutt Plow Co. Ltd., Brantford, Ont.
J. A. Wedlake, Methods Dept., Cockshutt Plow Co. Ltd., Brantford, Ont.

## OREGON CHAPTER

Harry Czyzewski, Pres., Metallurgical Engineers, Inc., Portland.
J. F. Ebele, Fdry. Supt., Western Foundry Co., Portland.
J. W. Goehler, Partner, Central Brass & Iron Foundry, Portland.
S. H. Krukowski, Electric Steel Foundry Co., Portland.
R. A. McGeorge, Jr., Finishing Frm., Western Foundry Co., Portland.
E. E. Meier, Frm., Central Brass & Iron Foundry, Portland.
J. F. Mellinger, Purch. Agent & Sales, Western Foundry Co., Portland.
R. R. Wagner, Dry Floor Man., Electric Steel Foundry Co., Portland.

## PHILADELPHIA CHAPTER

*General Grinding Wheel Corp., Philadelphia. (W. G. Pinkstone, V.P.).
Millard Borgeson, Fdry. Engr., Sorbo Mat Process Engineers, St. Louis, Mo.
William Chalfant, Sales, Griffith & Raguse Co., Inc., Philadelphia.
David Christie, Prod., Palmyra Foundry Co. Inc., Palmyra, N.J.
Louis Dill, Secy., George F. Pettinos, Inc., Philadelphia.
F. H. Goodfellow, Salesman, George F. Pettinos, Inc., Philadelphia.
Henry H. Hudson, Time Study, Link-Belt Co., Olney Fdry. Div., Philadelphia.
C. A. Johnson, Asst. to Dir. of Quality Control, U. S. Pipe & Foundry Co., Burlington, N.J.
F. J. Kelman, Asst. Sales Mgr., General Grinding Wheel Corp., Philadelphia.
G. F. Loewy, Abr. Engr., General Grinding Wheel Corp., Philadelphia.
J. E. Loewy, Abr. Engr., General Grinding Wheel Corp., Philadelphia.
C. Howard Megaw, Associated with V.P., K. Hettleman & Sons, Inc., Baltimore, Md.
W. A. B. Paul, Jr., Abr. Engr., General Grinding Wheel Corp., Philadelphia.
H. L. Smith, Chief Met., American Smelting & Refining Co., Federated Metals Div., Pittsburgh.
S. L. Steinruck, Salesman, George F. Pettiinos, Inc., Philadelphia.

## QUAD CITY CHAPTER

J. L. Briley, Supv., International Harvester Co., Rock Island, Ill.
Harold Brown, Asst. Met., John Deere Harvester Works, E. Moline, Ill.
O. S. Dakan, Fdry. Draftsman, J. I. Case Co., Rock Island Works, Rock Island, Ill.
C. W. Thornbloom, Molder Frm., Union Malleable Iron Works, E. Moline, Ill.

## SAGINAW VALLEY CHAPTER

C. W. Cordrey, Frm., General Foundry, Flint, Mich.
R. J. Duquette, Central Foundry Div., General Motors Corp., Saginaw, Mich.
W. H. Hall, General Motors Institute of Technology, Co-operative Student, Chevrolet Gray Iron Foundry, Saginaw, Mich.
G. C. Nash, Sales Engr., Detroit Electric Furnace Div., Kuhlman Electric Co., Bay City, Mich.
W. H. Somers, Sales Mgr., American Red Star Co., Detroit.

* Company Members

## ST. LOUIS DISTRICT CHAPTER

Chas. J. Scullin, Consultant, M. A. Bell Co., St. Louis, Mo.
O. E. Trampe, Abr. Engr., General Grinding Wheel Corp., Philadelphia.

## SOUTHERN CALIFORNIA CHAPTER

E. R. Andrews, Sales Engr., Independent Foundry Supply Co., Los Angeles, Calif.
E. V. Sumner, Field Tech., American Smelting & Refining Co., Federated Metals Div., Los Angeles, Calif.

## TENNESSEE CHAPTER

P. T. Bayless, Jr., Patternmaker, Harrison-Corry Co., Knoxville, Tenn.
C. C. Flory, Sales Repr., Laclede Christy Co., St. Louis, Mo.
J. W. Werner, Melt. Frm., The Wheland Co., Chattanooga.

## TEXAS CHAPTER

H. A. Graham, Tyler Pipe & Foundry Co., Tyler, Texas.
P. E. McAfee, Owner, El Pattern Shop, Dallas, Texas.
F. C. W. Ziegler, Jr., Sales Engr., Simonds Abrasive Co., Philadelphia.

## TIMBERLINE CHAPTER

L. E. Fletcher, Supt., Schlitter Iron Foundry, Denver, Colo.
T. P. McBreen, Owner, Schlitter Iron Foundry, Denver, Colo.

## TOLEDO CHAPTER

Shirrel Kasle, V.P., The Kasle Iron & Metal Co., Toledo.

## TRI-STATE CHAPTER

D. S. Deem, Dist. Repr., American Air Filter Co., Inc., Louisville, Ky.

## TWIN CITY CHAPTER

Ordean Egland, Partner, Modern Metals Foundry Co., Minneapolis.
Fred Goughnour, Salesman, W. S. Nott Co., Minneapolis.
L. N. Olsen, Salesman, W. S. Nott Co., Minneapolis.
J. E. Quest, Sec. & Treas., J. F. Quest Foundry Co., Minneapolis.
Arthur Tetzlaff, Partner, Modern Metals Foundry Co., Minneapolis.

## WASHINGTON CHAPTER

L. T. Wickard, Patternmaker, Seattle, Wash.
J. G. Young, Salesman, Brumley Donaldson Co., Seattle, Wash.

## WESTERN MICHIGAN CHAPTER

D. W. Deacon, Sales Repr., American Red Star Co., Detroit.
F. S. Pearson, Sec.-Mgr., Standard Sand Co., Grand Haven, Mich.

## WESTERN NEW YORK CHAPTER

R. T. Bailey, Supv., L.C. Fe. Cr. Dept., Vanadium Corp. of America, Niagara Falls.
R. J. Bryan, Plant Mgr., Allegheny Ludlum Steel Corp., Buffalo.
P. J. Cromwell, Sales, North American Smelting Co., Philadelphia.
D. W. Gaertner, Supt., Central Foundry Div., General Motors Corp., Lockport, N.Y.
C. E. Hopkins, Purch. Agent, Central Foundry Div., General Motors Co., Lockport, N.Y.
S. A. Kurnik, V.P., Aluminum Casting Co., Lancaster, N.Y.

## WISCONSIN CHAPTER

Walter Beese, Fdry. Frm., Milwaukee Flush Valve Co., Milwaukee.
H. W. Stokes, V.P. & Gen. Mgr., Thew Pattern Works, Inc., Green Bay, Wis.

# STUDENT CHAPTERS

## UNIVERSITY OF MINNESOTA

J. David Johnson

## MISSOURI SCHOOL OF MINES AND METALLURGY

John S. Absalom
Michael Lee Foster
Robert R. Penman

## OHIO STATE UNIVERSITY

Donald Rowland Dunlap
Harry E. Placke
Roy E. Retzke

## OUTSIDE OF CHAPTER

*Tredegar Co., Richmond, Va. (I. A. Kinsey, Exec. V.P.).
William M. Barron, Carnegie Institute of Technology, Pittsburgh, Pa.
R. B. Beisel, Jr., Ind. Engr., Aluminum Co. of America, Bridgeport, Conn.
J. Lester Davis, Supt. of Match Plate Fdry., Tredegar Co., Richmond, Va.
F. P. Dzwonkoski, Fdry Frm., Aluminum Co. of America, Bridgeport, Conn.
P. B. Eaten, Hd., Mech. Engr. Dept., Lafayette College, Easton, Pa.
John H. Guy, Jr., Sales Mgr. Castings, Tredegar Co., Richmond, Va.
A. L. Kearney, Met., Aluminum Co. of America, Bridgeport, Conn.
S. A. Kundraf, Fdry. Frm., Homestead Valve Mfg. Co., Coraopolis, Pa.
B. J. Lee, Salesman, George F. Pettinos, Inc., Philadelphia, Pa.
George Liff, V.P., Klein-Farris Co., Inc., Boston, Mass.

*(Continued on Page 69)*

# OPEN SWEDISH METAL RESEARCH INSTITUTE

*Measuring expansion of a Swedish molding sand specimen in a dilatometer oven in the sand laboratory of the Metallografiska Institutet, Stockholm. Most of the equipment was originally built to develop standards for testing sands.*

**Erik O. Lissell**
**Research Director**
**Sveriges Mekanforbund**
**Stockholm**

A NEW METAL RESEARCH INSTITUTE recently opened in Stockholm. Called Metallografiska Institutet (The Metallographic Institute) is to continue the successful work of the institution bearing the same name which was founded by Professor Carl Benedicks in 1920. Until 1946 the Institute was housed in the old buildings of the College of Mining and Metallurgy of the Royal Institute of Technology. The old institute was supported mainly by the Jernkontoret—the Swedish Ironmasters Association—and was engaged primarily in research problems related to iron and steel.

It has been felt for a long time that the accommodations were too crowded and not up to date, and in 1942 the board of directors of the institute and the Jernkontoret asked the Swedish Government for a new and better building. The Government suggested that the new institute should cover a wider field than the present and not only deal with ferrous problems but also with non-ferrous and asked for a broader support from that side of industry. As a result, the iron and steel industry, the non-ferrous metal industry and the mechanical engineering industries got together and formed the Society of Swedish Metal Research which supports the new Metallographic Institute.

The Metallographic Institute is beautifully situated in a park in the Northern part of Stockholm. On the grounds are two buildings—one main building and one building for melting and heat-treating. The two buildings are connected by a tunnel.

The main building houses offices, machine and carpenter shops, physical, chemical, x-ray, and metallographical as well as other service laboratories and a foundry laboratory. Not counting stairways and corridors the building provides a net floor space of about 17,500 sq ft.

The furnace and oven building consists of one bay roughly 18 ft high designed for melting, molding, casting, forging, and cleaning, and one lower ceilinged bay which contains furnaces, ovens and instruments for heat treating, vacuum fusion and vacuum melting of small heats. Each of these two bays occupies a floor space of roughly 2000 sq ft. The basement of the building provides space for storage, compressor, transformers, wash rooms, and a small machine shop.

### To House Modern Test Equipment

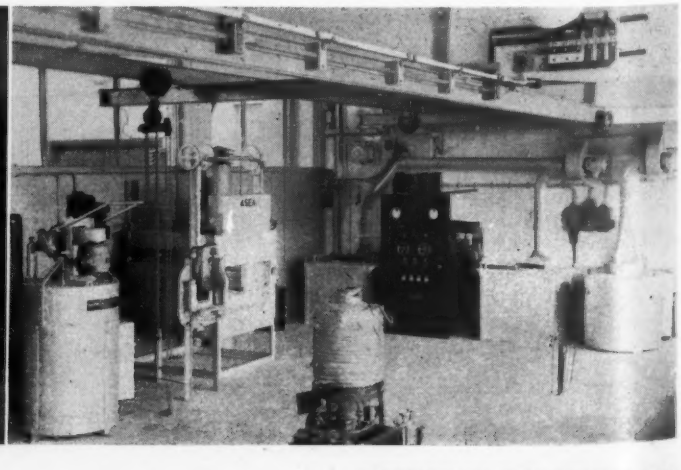
The institute, which is not yet in full-scale operation, will house all kinds of instruments and apparatus for fundamental research in metallurgy, metallography, and physics. Spectrographs, apparatus for x-ray crystallography, microscopes, instruments for determining physical constants, equipment for creep and corrosion testing, machines for the determination of the strength of metals, equipment for vacuum fusion, etc., are or will be installed in the institute.

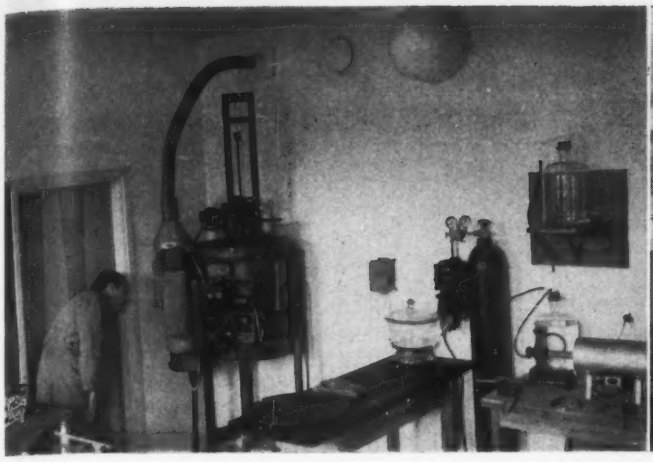
Service departments, such as shops for metal and wood working, preparation of test bars and specimens, melting and heat treating departments and chemical laboratories will contain up to date equipment.

The laboratory for melting and casting is equipped with a 100 kva, 2220 cycles completely automatic high frequency set, to which can be attached one 330 lb open furnace, one 66 lb open furnace and one 110 lb vacuum furnace. The furnace building contains also a 22 in.

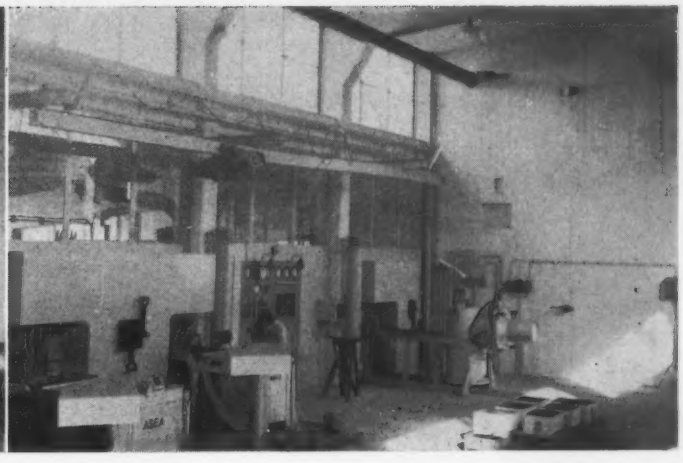
*Exterior view of Sweden's new Metallografiska Institutet (The Metallographic Institute). Stockholm.*

*The heat treatment laboratory features a salt bath, four high temperature furnaces and a lead pot.*





*The 24 kva core and mold drying oven in the Institutet's sand laboratory has three individual thermostats.*



*High frequency equipment can be used with open crucibles or for vacuum and special atmosphere melting.*

cupola especially equipped for the study of the behavior of the material charged in such furnaces. Two gas-fired crucible furnaces complete the installation.

Molding and core sands are prepared in a small sand preparation unit, consisting of a muller and a core mixer. Molds and cores are baked in a 24 kva electric oven with three individual thermostats. The shake out and cleaning department consists of a shake-out grind, sand blast cabinet, a grinding machine, and a work bench.

The heat-treating department is equipped with a 35 kva salt bath furnace and a lead pot. A 40 kva batch furnace makes treatments at high temperatures possible. The heat-treatment of light metals can be carried out in a 12 kva convection furnace. Special tests at very high temperatures and under vacuum can be conducted in a couple of special resistor type furnaces. Equipment for the analysis of gases in metals by means of vacuum fusion is included in this department.

Besides the equipment mentioned above, the foundry laboratory has access to a sand and a chemical laboratory. The sand laboratory includes sand mixers and apparatus for determination of the properties of foundry sands at room temperature as well as at elevated temperatures. Most of the equipment has been built by the laboratory in connection with the development of Swedish standards for testing foundry sands.

### Special Testing Ovens Used

A special core oven which works with a very high degree of uniformity and a high temperature oven for determining the compression strength at elevated temperatures, heat expansion tests and shock tests are shown on the illustrations.

The foundry laboratory which serves the Swedish foundry industry as a central research and control station works in close cooperation with the Metallographic Institute and utilizes the service laboratories and other departments of the institute when necessary.

Foundry research projects already underway include investigation on Swedish core binders, high temperature properties of Swedish sands, fluxes for nonferrous metals, degasification of copper-base alloys, solidification of gray iron, influence of inoculation on density and machinability of gray irons, and heat transfer in the drying of molds and cores.

*A view of the melting and casting laboratories of the Institutet, showing some of the cleaning equipment.*

## NEW MEMBERS

(*Continued from Page 67*)

C. W. Maddison, Instr., North Carolina State College, Raleigh, N.C.
Elmore M. Peloubet, Asst. Met., Aluminum Co. of America, Bridgeport, Conn.
B. C. Person, Student, University of Illinois, Urbana, Ill.
J. C. Shipman, Librarian, Linda Hall Library, Kansas City, Mo.
J. F. Wallace, Met., Watertown Arsenal, Watertown, Mass.
J. W. Warnock, Met., Aluminum Co. of America, Bridgeport, Conn.
C. W. Witters, Plant Met., Aluminum Co. of America, Bridgeport, Conn.
R. N. Williams, Salesman, George F. Pettinos, Inc., Philadelphia, Pa.
Edson L. Wood, Met., Springfield Armory, Springfield, Mass.
A. S. Wright, Met., Standard Foundry Co., Worcester, Mass.

#### Belgium

Andre M. A. Dawans, Civil Engineer, Adviser of Foundry, Rue d'Italie 4 Huy, Belgique.

#### China

J. Chow, Dir., Institute of Engrg., Academia Sinica, Shanghai.

#### England

E. W. Harding, Works Mgr., Goulds Foundries Ltd., Tredegar Foundry, Newport, Mon. S. Wales.
W. A. Turner, Partner, W. A. Turner, Jeffrey & Co., Royston, Herts.

#### France

Guy Henon, Dir., Centre de Recherches de Fonderie des Hauts, Paris.
Jean de Laclemandiere, Head, Tech. Documentation Dept., Regie Nationale des Usines Renault, Boulogne-Billancourt, (Seine).

#### Portugal

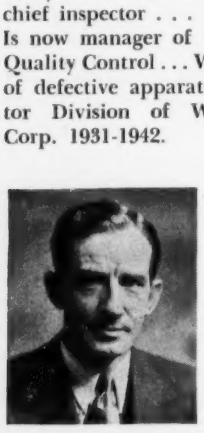
E. I. Pedroso, Chief Engr., Metallurgical Works, Companhia Uniao Fabril, Barreiro.

# WHO'S WHO

G. K. Eggleston and V. A. Simpson, co-authors of *"Controlling Quality in Castings Production,"* Page 55, are director of Research and manager of Quality Control, respectively, of the Barnes Mfg. Co., Mansfield, Ohio . . . Mr. Eggleston was born in Houghton, Mich., in 1903 . . . Attended Michigan College of Mining and Metallurgy . . . Joined Detroit Lubricator Co. in 1922 . . . Became chief metallurgist there in 1939 . . . Left to become foundry engineer for Barnes in 1941 . . . Appointed chief engineer in 1942 . . . Vice President in 1945 . . . Now holds dual positions as director of research and manager of Barnes' Pump Division . . . Virt A. Simpson joined Barnes February 15, 1942, as chief inspector . . . Is now manager of Quality Control . . . Was formerly in charge of defective apparatus for the Refrigerator Division of Westinghouse Electric Corp. 1931-1942.

**G. K. Eggleston**

**V. A. Simpson**



B. P. Mulcahy, *("Blast Variations Seriously Affect Cupola Operations,"* Page 34) is chairman of the Coal and Coke Research Committee of the American Coke & Coal Chemicals Institute . . . Born in Geneva, N.Y. in 1899 and attended Hobart College there . . . B.S. in chemical engineering from the University of Illinois in 1925 . . . Appointed chief chemist of Indiana Gas & Chemical Corp. in 1928 . . . Was research engineer for the Citizens Gas & Coke Utility, Indianapolis, from 1936 to 1947 . . . Is now in business for himself as a consultant in cupola operation and coal carbonization . . . Served on the Executive Committee for Cupola Research, A.F.A. and aided in preparation of the HANDBOOK OF CUPOLA OPERATION . . . He is a member of the Joint Committee on Coal Carbonization of the United States Bureau of Mines and the American Gas Association . . . Chairman of the Foundry Coke Specifications Committee of the A.C.C.C.I. . . . Member of the A.F.A.

**B. P. Mulcahy**

**J. G. Goldie**

J. G. Goldie, author of *"Apprentice Training or Short Term Training?,"* Page 60, is a member of the A.F.A. Apprentice Training Committee . . . Born in Barrhead, Scotland, and educated at Glasgow Technical College Returned to Barrhead to serve his apprenticeship . . . Came to this country in 1923 and worked in various foundries until 1928 . . . Became foundry instructor at the Meriden, Conn., State Trade School for two years . . . Headed the Foundry Division of the Cleveland, Ohio, Trade School for 16 years . . . Is now general superintendent of M.B.M. Foundry, Inc., Cleveland . . . Is Past President of the Cleveland Chapter of A.F.A.

**S. Denkinger, Jr.**

An ardent advocate of the use of plastic patterns in foundries is Steve Denking, Jr. (*"Plastic Pattern Technique"* Page 43) . . . Born in Milwaukee in 1918 . . . Served apprenticeship at Allis-Chalmers Mfg. Co. in patternmaking . . . Organized the Atlas Pattern Works, Milwaukee, in 1946, specializing in plastic patterns . . . Has addressed many technical groups on the subject . . . Is a member of A.F.A.

**O. L. Ducharme**

O. L. Ducharme, author of *"Know Your Cost Factors!"* Page 57, is factory and methods engineer for the Kindt-Collins Co., Cleveland . . . Born August 21, 1907, at Lowell, Mass., he attended high school there . . . Received his B.S. in mechanical engineering from Lowell Textile Institute in 1929 . . . Joined Saco-Lowell Machine Shop, Lowell, as a tool maker in 1929 . . . Appointed field engineer for Anderson & Nichols, Inc., New York, in 1933 . . . Division engineer for Youngstown Sheet & Tube Co. in 1935 . . . Methods engineer, Bunell Machine & Tool Co., Cleveland, 1938-41 . . . Production manager, Sommer & Adams Co., Cleveland, 1941-43 . . . Supervising engineer, Kenneth A. McIntyre & Associates, New York, from 1943 until he joined Kindt-Collins in 1946.

**H. A. Schwartz**

H. A. Schwartz, author of *"Blackheart Malleable Iron – Solved and Unsolved Problems,"* Page 46, is the author of this year's Williams Lecture, to be presented before the IBF in England this month by A. E. Peace, chief metallurgist, Ley's Malleable Castings Co., Ltd., Derby, England . . . Dr. Schwartz is the recipient of A.F.A.'s John A. Penton Gold Medal (1930) and the IBF's E. J. Fox Gold Medal (1939) . . . Born in Oldham, Ky., in 1880 . . . Holds three degrees from Rose Polytechnic Institute and was recently honored by that institution with an honorary Sc.D. . . . Started as draftsman with National Malleable Castings Co. in 1902 . . . Has been Director of Research for National Malleable & Steel Castings Co. since 1920.

## CHAPTER MEETINGS

JUNE 19

**DETROIT**
Lakewood Golf Club, Canada
ANNUAL OUTING

**PHILADELPHIA**
Langhorne Country Club, Langhorne
ANNUAL OUTING

**QUAD CITY**
Camp Nobel, Moline
ANNUAL PICNIC

JUNE 25

**NORTHEASTERN OHIO**
Pine Ridge Country Club
ANNUAL SUMMER OUTING

**NORTHERN CALIFORNIA**
Orinda Country Club
ANNUAL LADIES' NIGHT
ENTERTAINMENT AND DANCE

JUNE 26

**ST. LOUIS**
Lemay Grove
PICNIC

# FOUNDRY Personalities

**Raymond A. Quadt** has been appointed assistant manager of the general aluminum department of Federated Metals Division of the American Smelting and Refining Co. Mr. Quadt was formerly in charge of all Federated aluminum research operations at

**R. A. Quadt**

American Smelting's Central Research Laboratories. He has been with the company since 1942 and is a member of the Reclamation & Alloying Committee of the Aluminum and Magnesium Division of A.F.A., and a member of ASM and AIME.

**Lawrence A. Appley,** vice president of Montgomery Ward & Co. and a former deputy chairman and executive director of the War Manpower Commission, was recently appointed president of the American Management Association. Mr. Appley will assume control of the Association's

**L. A. Appley**

conferences, publications, and research projects. He will leave Montgomery Ward on July 1 to take over his new duties but will retain directorship in the company.

Mr. Appley succeeds **Alvin E. Dodd** who was appointed to the newly-created post of honorary president of the AMA.

**Graham J. Logan** has been appointed assistant superintendent of McConway & Torley Corp., Pittsburgh. Mr. Logan came to McConway & Torley in 1922 from the Verona Steel Castings Co. and has been associated with the foundry industry for more than 35 years.

A complete reorganization of supervisory personnel has been effected within the last three months by the Wilson Foundry &

**W. G. Hambley**

Machine Co., Pontiac, Mich., a subsidiary of Willys-Overland Motors.

**W. G. Hambley,** formerly research superintendent for Allis-Chalmers, foundry consultant for Kaiser-Frazer, and chief metallurgist of the Studebaker foundry division, has been elected Wilson's vice president and foundry manager.

Other appointments include: **F. C. Miles,** treasurer; **A. H. Shepard,** plant engineer; **H. A. Hyoner,** core room superintendent; **I. Mutsulavish,** assistant core room superintendent; **Edwin C. Radtke,** superintendent of service department; **T. C. Gallagher,** assistant general superintendent in charge of patterns and equipment; **Jack Burket,** superintendent of production; **John Madacey,** assistant foundry superintendent; **Bruce Norman,** general foreman; and **William Kaiser,** general foreman of the melting department.

**Wayne H. Gunselman,** director of research and foundry engineer for the Samuel Greenfield Co., Inc., New York, has been appointed general manager of the new Non-Ferrous Division of the Buffalo Pipe & Foundry Corp., Buffalo, N.Y.

The company recently acquired the assets of the American Sigma Corp., brass

**W. H. Gunselman**

and bronze foundry, and has expanded to include complete engineering, metallurgical and casting design service.

Mr. Gunselman was formerly chief metallurgist at the National Bronze & Aluminum Foundry, Cleveland. He is a member of A.F.A., ASM, ASTM and SAE.

**J. L. Mahon**

**James L. Mahon,** manager of the Detroit plant of the American Car & Foundry Co., ended 50 years of service with the company with his retirement on April 30.

Mr. Mahon started as a car checker in 1898, and served successively as purchasing clerk, audit clerk, and in the machine shop, wood mill and foundry. He served a term as storekeeper and traveling materials expediter. Mr. Mahon later became superintendent of plant, superintendent of foundries, and manager of the Detroit plant of the company.

An active civic worker, Mr. Mahon re-

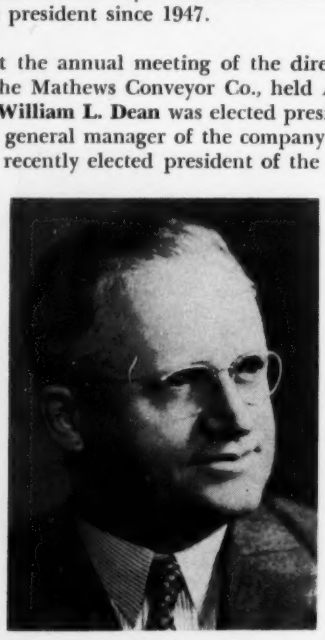
cently completed a term as president of the Detroit Fire Commission, of which he is still a member, and has been on the Wayne County Board of Supervisors and the Industrial Safety Council. He is president of Detroit's Old Newsboys Goodfellow Fund and has been chairman of the A.F.A. Detroit chapter.

**Charles R. Hook,** president of the Armco Steel Corp., since 1930, was recently elected chairman of the board and will continue

**C. R. Hook**

as chief executive officer of the company. Mr. Hook will be succeeded as president by **W. W. Sebald,** executive vice president, who has been with Armco since 1906, starting as an office boy. He has been executive vice president since 1947.

At the annual meeting of the directors of the Mathews Conveyor Co., held April 27, **William L. Dean** was elected president and general manager of the company. He was recently elected president of the com-



**W. L. Dean**

pany's Canadian and Pacific Coast subsidiaries—Mathews Conveyor Co., Ltd., and Mathews Conveyor Co., West Coast.

Mr. Dean has been associated with Mathews since 1909 and has been vice president and general manager since 1943.

At the same meeting Retiring President **F. E. Moore** was elected chairman of the board of directors of the company and of its subsidiaries.

*(Continued on Page 87)*

# A.F.A. CHAPTER DIRECTORY

**BIRMINGHAM DISTRICT CHAPTER**
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*Secretary-Treasurer,* A. D. Cummings, Western Foundry Sand Co.

**WESTERN MICHIGAN CHAPTER**
*Secretary,* D. A. Paull, Sealed Power Corp.

**WESTERN NEW YORK CHAPTER**
*Secretary,* F. L. Weaver, Weaver Materiel Service.

**WISCONSIN CHAPTER**
*Secretary,* A. C. Haack, Wisconsin Grey Iron Foundry Co.

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**MISSOURI SCHOOL OF MINES** *Secretary,* Stanley Zirinsky

**OHIO STATE UNIVERSITY** *Secretary-Treasurer,* Eldon Boner

**MASSACHUSETTS INSTITUTE OF TECHNOLOGY**
*Secretary-Treasurer,* Martin J. O'Brien

**OREGON STATE COLLEGE**
*Secretary,* John P. Meece

# CHAPTER ACTIVITIES NEWS

## Birmingham District

J. P. McClendon
Stockham Pipe Fittings Co.
Chapter Secretary

AN INTERESTING DISCUSSION on "More Profits to Foundries Through Cost Control and Wage Incentives" was presented by Arthur A. Clay, cost consultant of Lima, Ohio, at the April meeting of the Birmingham Chapter.

According to Mr. Clay, foundries are built and operated for three reasons: to make profits, to manufacture good castings, and to provide employment. To be successful in the foundry business, as in any other business, Mr. Clay said, sound cost control is essential if one is to make a profit.

Where different classes of work are manufactured, such as large and small work, difficult and less difficult work, etc., too many concerns figure sales price on an average cost per ton. Naturally, as a result of this, the less difficult work is priced higher than it should be and a competitor with a definite production cost control system may be able to sell products at a lower cost.

It follows that a cost based on a time study system is more correct than the old piecework price based on supervisors' judgment and past production records, Mr. Clay stated. Just because a molder has produced 50 molds per day for a period of time, it is no indication that he cannot produce more molds per day.

Time and motion standards bring to light the extra cost that is being included, such as down time spent in waiting for this and that, Mr. Clay added. Time values must be guaranteed to the worker and he must pay for all waiting time beyond his control. Thus, the division in actual cost of producing the molds and the cost of waiting time can be analyzed and the cause of excess cost can be eliminated.

Group methods of payment should be eliminated as far as possible, according to Mr. Clay. Even in the jobbing shop, he said, it is possible and practicable to establish time standards for standard elements. A planning committee could quickly compute additional cost beyond the standard elements on all new jobs as they come in, Mr. Clay concluded.

The nominating committee made its report on nominees for office. The election will be held next month. About 90 members and friends were present for the meeting.

## St. Louis

P. C. Schwarz
American Brake Shoe Co.
Chapter Reporter

AT ITS APRIL MEETING, the Chapter awarded prizes to winners in the local apprentice patternmaking contest. The meeting had the largest attendance of the year. In addition to the awarding of the prizes, the meeting featured an address by Dr. William Barr, research and standards consultant for the Union Pacific railroad, who spoke on the inspection and production of large railroad castings. Many of the castings discussed by Dr. Barr were made in the St. Louis area.

*Winners of prizes in a local apprentice patternmaking contest conducted by the St. Louis Chapter are, left to right, Curtis Tucker, ninth prize; Gene Keatzel, sixth prize; Ralph Trump, fifth prize; Don Schlaffer, fourth prize; William Burkholder, third prize; Alfred Sandweg, second prize; and Martin Foller, first prize. Cash awards, ranging from $2 to $15, were offered as a supplement to the National Apprentice Contest.*

*Lester B. Knight of Lester B. Knight & Associates speaking at the April meeting of the Cincinnati District.*

## Cincinnati District

C. H. Fredericks
Cincinnati Milling Co.
Chapter Reporter

THE LARGEST GROUP ever to attend a meeting of the Chapter heard Lester B. Knight, Lester B. Knight & Associates, speak on "Mechanization in the Foundry" at the April 12 meeting at Dayton.

In his opening remarks, Mr. Knight stated that mechanization in the foundry is not the complete answer to making quality castings at a profit. The volume of business must be such that the investment can be amortized over the shortest possible period of time without having to increase the price of the castings, he said.

Mr. Knight stated that there are several factors that must be considered before attempting modernization of a foundry. The factors are:

Housekeeping—all necessary equipment must be arranged in orderly fashion so that no time will be lost by workmen in procuring necessary equipment.

Arrangement of facilities in a foundry must be such that the work flows in a straight line and raw materials and finished products handled as few times as possible.

All jobs must be analyzed in a critical manner to determine the possibility of rigging pattern or core box equipment in a different way or of changing flask sizes to increase efficiency of molding and core making operations, thus decreasing costs.

A good wage incentive plan is a tool that must not be overlooked. Some remarkable results can be obtained from its use.

A good educational program for the supervisory personnel, to enable them to take the utmost advantage of facilities at hand.

After all of the above factors have been attended to it is then time to determine if it will be profitable for the plant, or any phase of it, to be mechanized, he concluded.

*National officers and guests at the April 16 meeting of the Texas Chapter, held in Lufkin, are, left to right: National Director F. M. Wittlinger, S. D. Martin, General Motors Corp., guest speaker; E. P. Trout, vice president of the Lufkin Foundry & Machine Co.; James H. Smith, National Director; Colonel C. C. Chambers, Texas Foundries, Inc.; President Max Kuniansky, and A. J. Haswell, retiring president, Foundry Educational Foundation.*

## Texas Chapter

Malcolm J. Henley
American Cast Iron Pipe Co.
Publicity Chairman

MORE THAN 225 SOUTHWESTERN FOUNDRYMEN met in Lufkin for a one day conference, which included a National Officers meeting, plant visitations, a Management luncheon, and a dinner meeting.

Guests for the occasion included Max Kuniansky, National A.F.A. President; Anthony Haswell, retiring president of the Foundry Educational Foundation; National

*A few of the National and Chapter Officers and directors attending the Management Luncheon of the Texas Chapter at Lufkin as guests of the Lufkin Foundry & Machine Co., and Texas Foundries, Inc. Anthony Haswell, retiring President of the Foundry Educational Foundation, spoke at the Management Luncheon. Mr. Haswell outlined the program of the FEF, and urged participation by Texas foundries and schools.*

Director James H. Smith; and S. D. Martin, production manager of the Central Foundry Division, General Motors Corp.

Jack Klein, vice president of Texas Foundries, Inc., was chairman of arrangements and worked with Chapter Chairman Marvin Williams, Hughes Tool Co.

Texas Foundries, Inc., and the Lufkin Foundry & Machine Co. were hosts to the Management luncheon, at which Col. C. C. Chambers, president and general manager of Texas Foundries, introduced the speaker, Mr. Haswell. He explained the progress of the FEF and told how Southwestern foundrymen could and should participate in the program. Two prominent Texas educators, Prof. B. B. Begeman, head of Texas University's mechanical engineering department, and Prof. Charles Crawford, head of the mechanical engineering department of Texas A & M, were guests at the luncheon.

During the afternoon, National President Kuniansky met with directors of the Texas Chapter to discuss chapter activities and the national program.

The technical meeting was held at Texas Foundry's Canteen. National Director J. H. Smith spoke on "Progress with Motion Study," in which he pointed out that any job could be improved with very little expense by motion analysis.

Mr. Smith was assisted in his talk and demonstrations by Mr. Martin. The talk was illustrated by a motion picture showing General Motors' Saginaw, Mich., plant before and after "motion analysis."

The group then moved to the Angelina hotel ballroom for the dinner meeting. Mr. Kuniansky spoke on "American Foundrymen's Association Activities." He stated that the A.F.A. had made wonderful progress in the last few years, but in his opinion the future looked even brighter. President Kuniansky added that the proper selection of committeemen in each Chapter is essential to the progress of A.F.A.

## Southern California

Leo N. Wood
Triplett & Barton, Inc.
Chapter Reporter

MORE THAN A SCORE of Southern California foundrymen attended the A.F.A. Foundry Congress in Philadelphia, including National

*Sharing a table at the April 9 meeting of the Southern California Chapter are, clockwise starting front left: H. M. Donaldson, Brumley-Donaldson Co.; C. C. Woolsey and Dr. W. O. Whetmore, Naval Ordnance; Robert Hongola,, G. Extale, B. A. Benton and Max Kunzman, all of General Electric.*

*R. D. Sangster, Los Angeles Chamber of Commerce (left), "coffee talker" at the April 9 meeting of the Southern California Chapter, pictured with Chapter President Henry E. Russill (center) and Kenneth L. Clark, International Nickel Co., technical speaker of the evening.*

Director Elect Robert R. Gregg, John Hayett, James Barr, W. O. Wetmore, George Emmett, Jack Crawford, W. D. Emmett, Earle Shomaker, Leonard Hoffstetter, John Wilson, Henry Howell, Charles McGraw, Kenneth Clark, Jerry Nass, L. D. and Robert Kay.

The April session was highlighted by an invitation from Robert Loeb, manager of the Rodger Young Auditorium, scene of the Chapter's dinner meetings, for the members of the Chapter to be his guests for the May meeting.

Speakers at the April meeting were R. D. Sangster, of the Industrial Materials division, Los Angeles Chamber of Commerce; and Kenneth L. Clark, technical representative for the International Nickel Co.

Mr. Sangster discussed reasons why the West is not getting enough merchant iron, based on letters from various steel executives. His conclusions, based on this survey, were summarized as follows:

Coke and scrap are in short supply and will remain so. While some coke is finding its way to the West Coast from Western sources, most of it is going East. High priced and inferior scrap is the rule, not the exception. Many poor castings owe their flaws to badly sorted and below-par scrap. The West, he said, is the steel industry's "orphan."

*Dale Hall (left), Oklahoma Steel Castings Co., and R. W. Trimble, Bethlehem Supply Co., talk things over with National President Max Kuniansky during the April 14 Board meeting of the Tri-State Chapter at Tulsa.*

*Pictured at a recent Board of Directors meeting of the Tri-State Chapter are, left to right: National President Max Kuniansky, Clyde B. Fisher, Empire Pattern & Foundry Co.; Chapter Chairman R. W. Trimble, Bethlehem Supply Co.; M. C. Helander, Empire Pattern & Foundry Co.; F. G. Lister, Chicago Pneumatic Tool Co.; Chapter Chairman-Elect Dale Hall, Oklahoma Steel Castings Co.; and F. R. Westwood, Sr., Service Foundry, Inc.*

*Above — National President-Elect William B. Wallis addressing the April 20 meeting of the Eastern New York Chapter at Circle Inn, Albany. Mr. Wallis spoke to more than 90 members and guests on the aims and policies of the Association.*

*Below—H. C. Winte, Motor Castings Co., Milwaukee, Wisconsin, speaking on "Gates and Risers" at the April 9 meeting of the Eastern Canada & Newfoundland Chapter, Mount Royal Hotel, Montreal.*

As to the outlook for improvement, he concluded, letters from Western suppliers indicate a "consciousness of this shortage on the Coast," but make no definite commitments as to possible betterment of the situation.

Mr. Clark spoke on "Variables in Foundry Practice." In the fields of melting, heat treating and molding, he said, variables are best handled by close reasoning based on accurate knowledge. Among the points brought out by Mr. Clark were:

As an illustration of variable scrap, a single lot of stainless steel, so-called, contained only 23 per cent of stainless. Physical form of scrap must be analyzed in relation to melting technique, and accurate records must be kept of all melting operations, he said.

Coke varies in ash content from 5 to 15 per cent; sizes should be 10 per cent of cupola diameter; too friable coke breaks down and restricts gas flow. On gas flow and control, temperatures must be recorded and kept as guides.

Sand is the biggest variable in molding. Bonding materials, fluxing action of impurities and moisture content must be recognized as vital to production.

The old adage, "pour 'em hot and pour 'em fast," is not always good practice, he said. Much depends upon how risering and gating is arranged. This, in turn, should be predicated upon the basic idea that castings freeze in the form of an envelope, which starts solidification from the outside.

President Russill at the conclusion of the meeting announced the new roster of officers to be installed at the June meeting.

## Rochester

**G. M. Etherington**
**Gleason Works**
**Chapter Reporter**

NATIONAL OFFICERS' NIGHT, held March 9 at the Seneca hotel, Rochester, featured as guest speaker A.F.A. National Vice President W. B. Wallis and Ray Quadt, chief of Aluminum Section, American Smelting & Refining Co.

Mr. Wallis cited the fact that A.F.A.'s membership is now greater than ever before and spoke of the Association's various activities, which currently include eight research programs, publication of

*(Continued on Page 79)*

# NEW Foundry Products

**Readers interested in obtaining additional information on items described in New Foundry Products should send requests to Reader Service, American Foundryman, 222 W. Adams St., Chicago 6, Ill. Refer to the items by means of the convenient code numbers.**

## Sand Conditioner

**JN1**—With only one man at the controls, the new Royer DPL Self Loading Sand Conditioner moves directly into a sand heat, scoops up the sand and feeds the built-in Royer "Combing Belt" Sand Separator, which culls out trash and discharges 40 to 50 tons of conditioned sand per hour. The machine forms a compact

unit 7 ft 3 in. high, 5 ft 4 in. wide, and 7 ft 3 in. long and weighs approximately 5100 lb. The three motors required to operate the machine—travel, bucket loader and combing belt—use a total of only 11 hp. Switches are located on easy-to-reach panel. Specification sheets available from manufacturer.

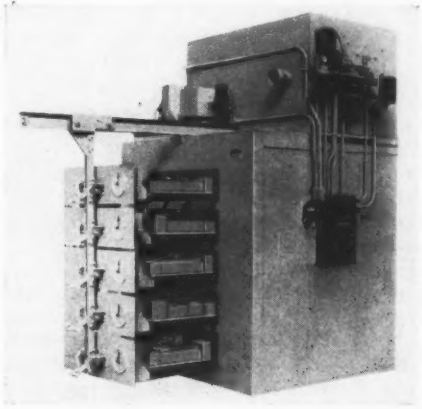
## Portable Compressors

**JN2**—Two portable fractional horsepower air compressors are announced by American Brake Shoe Co.'s Kellogg Division. Popularly priced, both models pro-

duce 100 per cent oil free air. Special designing eliminates all contact or contamination of air with lubricating oil. Model 17-C (illustrated) delivers 4.4 cfm free air at 40 lb pressure and features new lubricated-for-life sealed oil bearings. Encased in welded steel frames, the compressor has readily accessible twin air cleaners. Model 8-C delivers 2.2 cfm at 25 lb pressure and is equipped with a single air cleaner and powered with a ¼ hp motor. Force feed oil system assures positive lubrication.

## Drawer-Type Oven

**JN3**—An improved all-purpose drawer-type oven, designed by the Despatch Oven Co., is compact, self-contained and factory wired and shipped assembled for inexpensive installation. Unit fan and heater are enclosed in an insulated box mounted on top of oven body. Rugged vertical support bar does not interfere with loading from any angle. Overhead rail suspension of heavy cast iron rollers permits smooth drawer action. Rear plug on



drawer seals oven against heat loss when drawers are open. 24 standard models of 3, 4 or 5 drawer types—gas, oil or electric fired, with forced convection are available. Drawers range in size from 30x36 in. to 48x72 in.; from 8 in. to 18 in. in depth.

## Time Switch

**JN4**—A handy time switch, Type T-47, rated 35 amp at 115 and 230 volts and timed and operated by synchronous, self-starting lubricated motor, is announced by the General Electric Co. The new switch has a wide application in small industries for controlling ovens and similar equipment, the switch is designed for on and off timing of a single circuit and will perform one such operation during any 24-hr period without adjustment.

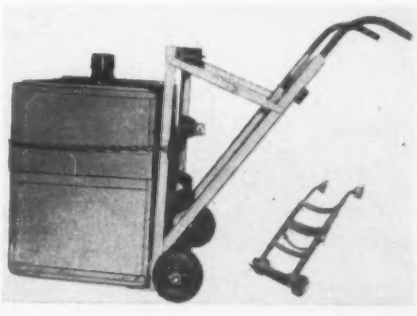
## Transfer Ladle

**JN5**—A transfer ladle designed for lift trucks developed by Yale & Towne Mfg. Co. is capable of receiving three tons of molten metal directly from the fixed mixing ladle at the cupola; transporting the metal to the pouring ladles at various casting stations; and filling them as required. Ladle, lined with refractory brick, is permanently mounted on a heavy fabricated skid engaged by the platform of the truck and pinned thereto. While ladle is working, it is an integral part of the lift truck platform. Rotation of ladle for

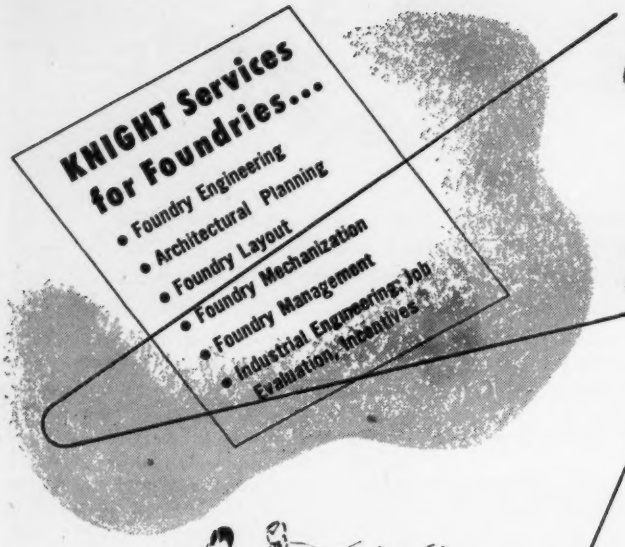
pouring is hand-controlled from truck driving positions. Transfer ladles mounted on lift trucks are not restricted to overhead crane and monorail paths.

## Hand Truck

**JN6**—A lightweight, sturdy hand truck, combining many safety features is now available from General Scientific Equipment Co. Constructed of riveted, welded and bolted frame, with tubular handles, the Safety All-Purpose Hand Truck has two carrying positions—in the open position the truck can be used to move tanks,



barrels and packages in a vertical position to avoid spilling contents; in the closed position the truck can be used as a hand truck to transport boxes, barrels and similar items in the conventional manner. Price: $29.50 equipped with aluminum wheels; $32.50 equipped with rubber tires.




# Successful FOUNDRY MODERNIZATION Requires SPECIALIZED ASSISTANCE BY EXPERIENCED ENGINEERS

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● Foundry Engineering—The many complex problems confronting foundry owners and managers challenge the decision of any one man or group of men who have not had the opportunity to make similar decisions before. Knight engineers are thoroughly familiar with foundry problems and their economical practical solutions.

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● Foundry Layout—An analysis of your foundry by Knight engineers will result in a new projected layout with rearranged existing facilities plus recommended new facilities and the comparative operation costs of the old and new layouts.

● Foundry Mechanization—After an analysis of your plant the Knight organization will specify equipment best suited for desired production and supply specifications to the foundry's acceptable suppliers for price quotations and delivery.

● Foundry Management—Several Knight engineers, with many years of management experience in various types and sizes of foundries, are particularly qualified to take over temporary management of your foundry or to work with you in ironing out management problems.

● Industrial Engineering; Job Evaluation, Incentives—General foundry practices must be as modern as the facilities. An efficiency survey of your plant by men of the Knight organization will result in specific recommendations for betterment of labor-management relations, establishment of fair wage incentives, standards and cost control which will pay management big dividends in increased production and profit.

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## CHAPTER ACTIVITIES

(*Continued from Page 76*)

technical information, and active support of the Foundry Educational Program.

Guest technical speaker of the evening Ray Quadt had as his subject, "Certain Aluminum Foundry Problems, Their Causes and Elimination." Mr. Quadt mentioned melting and pouring problems and such factors as mold design, gates, risers and chills, emphasizing the proper preheat of the metal, fluxes and sources of gas. The talk was followed by a discussion period.

### Birmingham

**J. P. McClendon**
**Stockham Pipe Fittings Co.**
**Publicity Chairman**

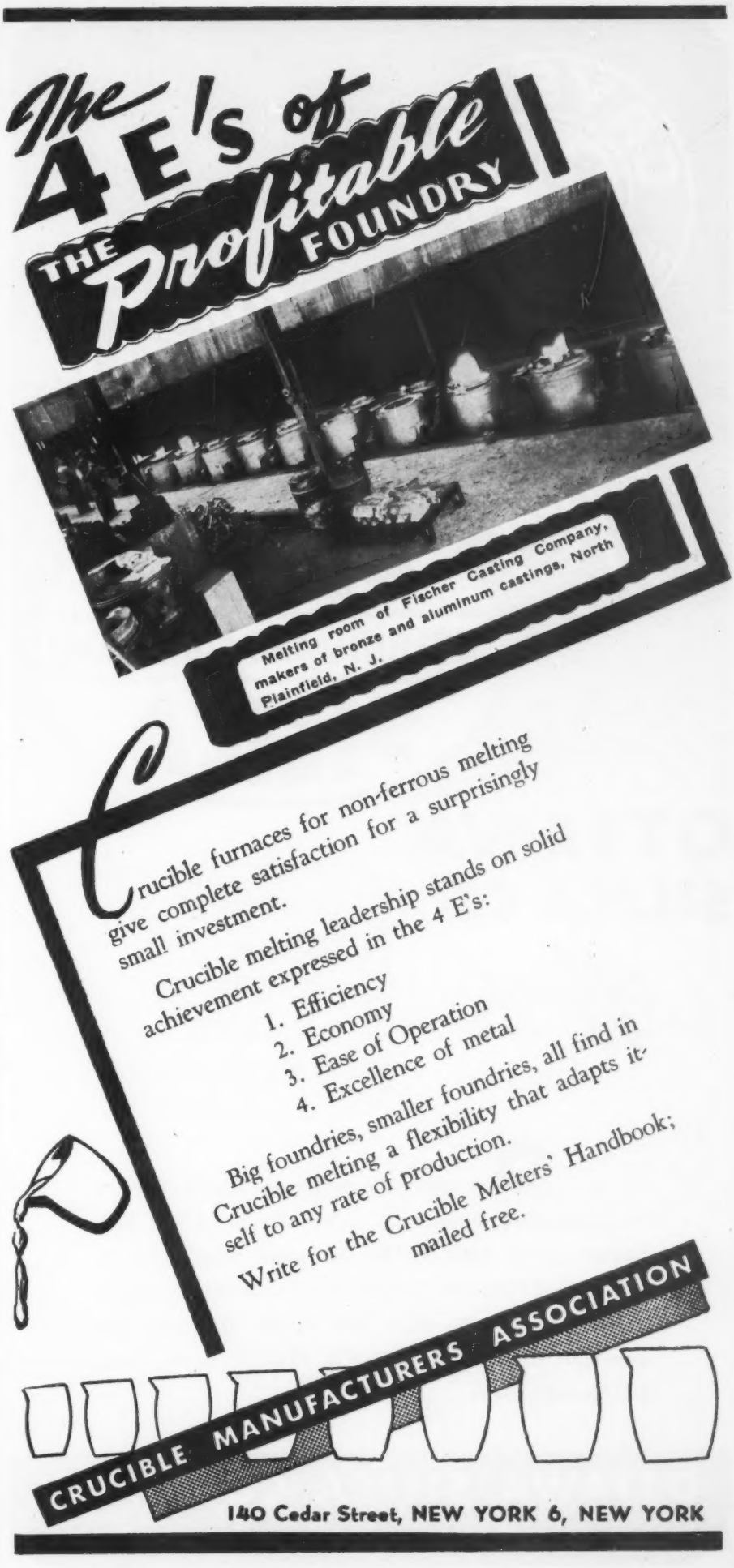
BIRMINGHAM'S Annual Quiz Program as usual proved to be filled with good, sound advice on the handling of individual foundry problems.

More than 50 members attended the dinner and business meeting preceding the technical session. Chapter Chairman W. E. Jones presided at the dinner.

Tom H. Benners, A.F.A. National Director Elect, quizmaster for the session, introduced the experts: C. P. Caldwell, president, Caldwell Foundry & Machine Co.; Dr. R. W. Sandelin, chief metallurgist, Stockham Pipe Fittings Co.; J. R. Kottus, chief metallurgist, Anderson Brass Works; Norman E. Pugh, Gray Iron Foundry superintendent, Stockham Pipe Fittings Co.; James A. Bowers, melting superintendent, American Cast Iron Pipe Co.; W. H. Spencer, sales engineer, DeBardeleben Coal Corp.; H. W. Gethin, vice president, Alabama Clay Products Co.; Frank H. Coupland, foundry superintendent, American Cast Iron Pipe Co.; and Charles K. Donoho, chief metallurgist, American Cast Iron Pipe Co.

Questions addressed to the experts were dropped into a box, together with the name of the writer. The session began with a brief outline of the advantages and disadvantages of "Convertible Steel and Electric Furnace Steel" by C. P. Caldwell.

Refractories questions were handled by H. W. Gethin. In answer to a question on the short life of a mixing ladle, Mr. Gethin recommended that a high-grade mortar mix be used when lining the ladles, and emphasized the joint as the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**OTTAWA SILICA COMPANY**
**Ottawa, Illinois**

weakest point of the lining, adding that it should have special attention to insure maximum service.

Presentation of an actual casting for warping and thickness diagnosis brought out much discussion and valuable information.

Frank H. Coupland handled the questions on sand. His answers were well-founded and thoroughly convincing, particularly those on the merits of sea coal.

Questions were all well-chosen and the experts did an excellent job in answering them.

### Metropolitan Chapter

**W. H. Ferguson**
**Electro Metallurgical Sales Corp.**
**Chapter Reporter**

THE FINAL MEETING OF THE YEAR was held April 5 at Essex House, Newark, N.J. K. A. DeLange, Chapter chairman, presided at a business meeting and presented his report of the year's activities. Since no petitions had been presented nominating additional candidates, the chairman asked the secretary to call for a unanimous vote for 1948-49 officer and director selections of the nominating committee.

G. W. Talbot, Copper Alloys Foundry Co., acted as technical chairman for the meeting, at which C. R. Simmons, Durez Plastics and Chemicals, Inc., spoke on the accelerated phenolic resin type of patternmaking material. He demonstrated the actual use of this type of material and explained necessary precautions to be followed, including proper coating and lubrication of master molds.

The advantages of this material over wood or metals, as cited by Mr. Simmons are: low shrinkage, its adaptability to experimentation and small production runs, makes duplication of old equipment easy, can make difficult patterns, and permits quick volume production.

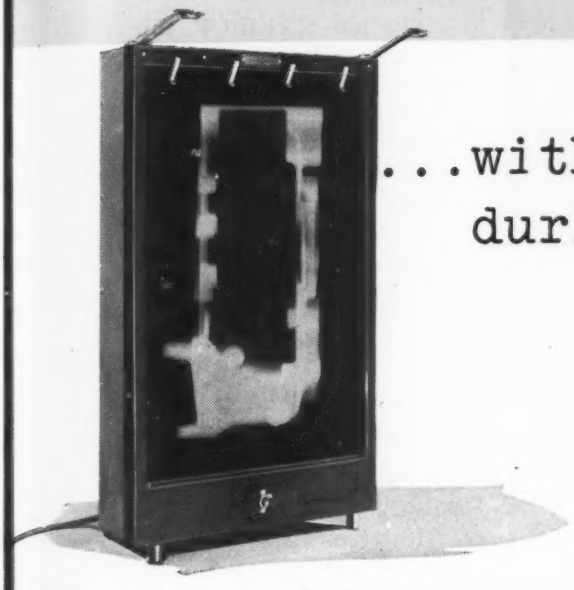
Following Mr. Simmon's talk, Franz Schumacher, Copper Alloys Foundry Co., demonstrated his company's method of making plastic patterns and inserting them in matchplates.

George Ledermann, Ledermann & Bessler, spoke briefly on "Rigging for Core Blowing," in which he stressed proper design of core boxes for orifice location and adequate venting to enable rapid dissipation of air volume.

*(Continued on Page 82)*

# Increase sound casting yield...

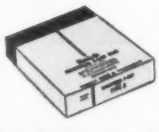
Progress in increasing sound foundry yield is due largely to foundrymen's adoption of new and proved practices and technics—both before and during production runs. Radiography is contributing greatly to improving foundry methods by providing records of the internal condition of the casting for detailed study.



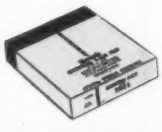
# ...with radiography before and during production runs...

Radiographic examination of pilot castings helps develop sound technics quicker . . . gets full production runs going sooner. Used as a spot check, radiography assures uniformly sound casting output. Result: radiography reduces rejections . . . increases sound yield . . . more than pays its own way.

# For maximum radiographic visibility- use Kodak Industrial X-ray Films...

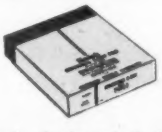


**Kodak Industrial X-ray Film, TYPE A** . . . for x-ray and gamma-ray work in sections where fine grain and high contrast are desirable for maximum sensitivity at moderate exposure times.



**Kodak Industrial X-ray Film, TYPE K** . . . designed for gamma-ray and x-ray radiography of heavy steel parts, and of lighter parts at limited voltages where high film speed is needed.

**Kodak Industrial X-ray Film, TYPE M** . . . first choice in critical inspection of light alloys, thin steel at moderate voltages, and heavy alloy parts with million-volt equipment.



**Kodak Industrial X-ray Film, TYPE F** . . . with calcium tungstate screens—primarily for radiography of heavy steel parts. For the fastest possible radiographic procedure.

They provide the high radiographic sensitivity —the combination of speed, contrast, and fine grain—required for the detail visibility you need in critical examination of castings.

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Buehler specimen preparation equipment is designed especially for the metallurgist, and is built with a high degree of precision and accuracy for the fast production of the finest quality of metallurgical specimens.

1. No. 1315 Press for the rapid moulding of specimen mounts, either bakelite or transparent plastic. Heating element can be raised and cooling blocks swung into position without releasing pressure on the mold.

2. No. 1211 Wet power grinder with ¾" hp. ball bearing motor totally enclosed. Has two 12" wheels mounted on metal plates for coarse and medium grinding.

3. No. 1000 Cut-off machine is a heavy duty cutter for stock up to 3½". Powered with a 3 hp. totally enclosed motor with cut-off wheel, 12" x 3/32" x 1-1/4".

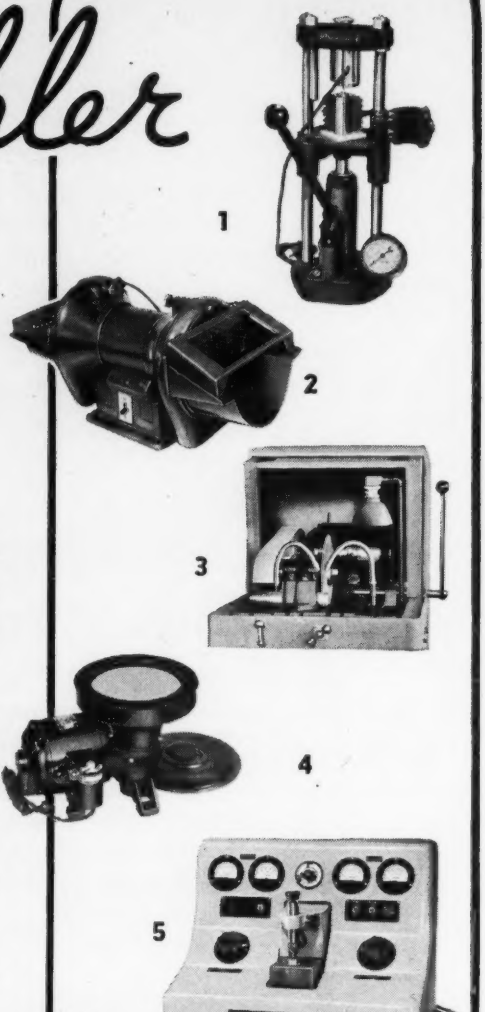
4. 1505-2AB Low Speed Polisher complete with 8" balanced bronze polishing disc. Mounted to ¼ hp. ball bearing, two speed motor, with right angle gear reduction for 161 and 246 R.P.M. spindle speeds.

5. No. 1700 New Buehler-Waisman Electro Polisher produces scratch-free specimens in a fraction of the time usually required for polishing. Speed with dependable results is obtained with both ferrous and non-ferrous samples. Simple to operate—does not require an expert technician to produce good specimens.

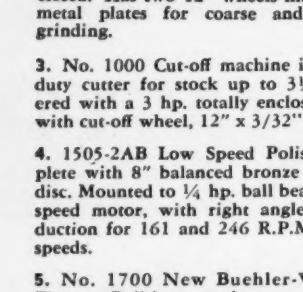
6. No 1410 Hand Grinder conveniently arranged for two stage grinding with medium and fine emery paper on twin grinding surfaces. A reserve supply of 150 ft. of abrasive paper is contained in rolls and can be quickly drawn into position for use.

7. No. 1400 Emery paper disc grinder. Four grades of abrasive paper are provided for grinding on the four sides of discs, 8" in diameter. Motor 1/3 hp. with two speeds, 575 and 1150 R.P.M.

8. No. 1015 Cut-off machine for table mounting with separate unit recirculating cooling system No. 1016. Motor 1 hp. with capacity for cutting 1" stock.




**The Buehler Line of Specimen Preparation Equipment includes . . .** Cut-off Machines • Specimen Mount Presses • Power Grinders • Emery Paper Grinders • Hand Grinders • Belt Surfacers • Mechanical and Electro Polishers • Polishing Cloths • Polishing Abrasives.



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# CHAPTER ACTIVITIES

*(Continued from Page 80)*

## Wisconsin

A. C. Haack
Wisconsin Grey Iron Foundry
Secretary

THE FOLLOWING MEMBERS were nominated for 1948-49 officers and directors of the Wisconsin chapter.

*President,* R. C. Woodward, Bucyrus-Erie Co.; *vice president,* Arthur C. Haack, Wisconsin Grey Iron Foundry Co.; *secretary,* Walter W. Edens, Badger Brass & Aluminum Foundry Co.

The late Richard F. Jordan was nominated for the office of treasurer but died April 5. A new treasurer will be appointed when the new president takes office, and at the same time two new directors will be named for 1948-49.

## Tri-State

F. E. Fogg
Acme Foundry and Machine Co.
Publicity Chairman

H. L. SMITH, CHIEF METALLURGIST, Federated Metals Division American Smelting & Refining Co., Pittsburgh, was the principal speaker at the March meeting, held at the Mayo hotel, Tulsa, March 19.

Although Mr. Smith's talk, "Problems Connected with the Melting of Brass and Bronze," dealt with non-ferrous metal, it brought many questions from iron and steel men.

Mr. Smith stressed the importance of dissolved gases in non-ferrous metals, their mechanization, chemical reactions, and elimination of detrimental results. By simple diagram, he illustrated the harm done by very small percentages of moisture and gases in the melting of brass and bronze. Mr. Smith also discussed gate and riser methods.

## Massachusetts Institute of Technology

Loris Diran
Technical Secretary

THE M.I.T. STUDENT CHAPTER held its second monthly meeting April 8 in the Institute Foundry. Following dinner, John Holmes and Edward Lawrence, graduates of the Class of 1947, and now employed in the Foundry division of the General Electric plant at Schenectady, N.Y., gave short talks on what the graduate engineer can expect in his first year in the foundry industry. Particular emphasis was given to the fact that the industry

has much to offer in the way of training and that the amount given depends upon the attitude and cooperation of the new employee.

Principal speaker was C. W. Briggs, technical and research director of the Steel Founders' Society, who spoke on "The Design of Steel Castings." Using sound pictures, Mr. Briggs discussed the basic principles necessary to the production of high quality steel castings and stressed the importance of cooperation between the foundryman and the design engineer. More than 50 students and guests attended.

### Oregon

W. R. Pindell
Northwest Foundry & Furnace Co.
Chapter Reporter

AT THE MARCH MEETING, held at the Heathman Hotel, Portland, Harry Dahlberg, assistant professor of Industrial Arts, Oregon State College, announced the formation of an A.F.A. Student Chapter at Corvallis, the fifth of its kind in the country.

Mr. Dahlberg stated that there would be about 30 students graduating in engineering from Oregon State this June who want to become active in the foundry industry.

A motion picture showing the production of magnesium by the salt water process and the precision work and modern molding methods employed in the magnesium foundry was presented.

The speaker of the evening was Al Zima, International Nickel Co., who addressed the group on "Modern Developments in the Foundry Industry." He spoke on centrifugal, centrifuge and permanent mold castings, illustrated with slides.

Mr. Zima pointed out that the West Coast is generally lagging in production methods and needs development in new types of molding in order to compete with Eastern and Midwestern foundries on manufactured items. Mr. Zima also cited the advantages of plastic patterns.

### Northeastern Ohio

R. D. Walter
Werner G. Smith Co.
Chapter Secretary

CHAPTER OFFICERS AND DIRECTORS nominated for the 1948-49 season at the April meeting are:

*President,* E. C. Zirzow, National Malleable & Steel Castings Co.; *vice president,* Walter E. Sicha, Alumi-


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*Directors (terms expire 1949)*: F. L. Barton, Fulton Foundry and Machine Co.; William G. Gude, Penton Publishing Co.; Fred J. Pfarr, Lake City Malleable Co.; Vincent J. Sedlon, Master Pattern Co.; and C. S. Winter, Duplex Manufacturing & Foundry Co.

*Directors (terms expire 1950)*: Gerald M. Cover, Case Institute of Technology; E. G. Fahlman, The Permold Co.; Gilbert J. Nock, The Nock Fire Brick Co.; John Schneider, Cleveland Electric Illuminating Co.; and John M. Urban, the Fanner Manufacturing Co.

*Directors (terms expire 1951)*: Lewis T. Crosby, Sterling Wheelbarrow Co.; Lloyd W. Leesburg, Superior Foundry, Inc.; Henry C. LeBeau, Ohio Injector Co.; Maurice F. Degley, Ferro Machine and Foundry Co.; and John A. Sharritts, Westinghouse Electric Co.

### Central Michigan


C. C. Sigerfoos
Michigan State College
Chapter Vice-Chairman


THE CENTRAL MICHIGAN CHAPTER met at the Hotel Schuler, Marshall, Mich., April 20 to hear V. J. Sedlon, president of the Master Pattern Co., Cleveland, Ohio, on "The Factors in Selecting Pattern Equipment."

Mr. Sedlon directed his talk principally to buyers of patterns and castings, and pointed out that the materials and workmanship of a pattern should be kept in line with the number of castings desired and the design of the casting. For example: the speaker mentioned that a soft wood pattern is usually satisfactory where the design is simple and the number of castings desired is small. On the other hand, he said, where the design is complex and the number of castings required is large, it is usually best to make hardwood or metal patterns.

Mr. Sedlon advised pattern buyers to consult with the pattern shop and foundry to make sure that they are in agreement as to the way in which the job should be made. He concluded his talk by showing slides of typical modern pattern equipment and of the steps necessary to complete a complicated pattern and core box arrangement.

# PERSONALITIES

*(Continued from Page 72)*

Sloss-Sheffield Iron & Steel Co., Birmingham, Ala., announces the following changes in top executive personnel:

**Hugh Morrow,** president since 1925, has been elected chairman of the board of directors. Mr. Morrow will be succeeded as president by **C. S. Lawson,** vice president. All other officers and directors were re-elected.

**J. L. McCloud** has been appointed director of chemical engineering and metallurgical research for the Ford Motor Co., Dearborn, Mich., succeeding the late Russell Hudson McCarroll, A.F.A. National Director who died March 31.

A graduate in chemical engineering from the University of Michigan in 1913, Mr. McCloud joined Ford as a chemist in 1915, later becoming chief chemist of the Henry Ford & Son Tractor Co. In 1920, he was transferred to the Dearborn Engineering Laboratories, and in 1936 to the chemical engineering department of the Rouge plant.

Mr. McCloud was appointed assistant director of chemical engineering and of chemical and metallurgical research in 1946.

Allis-Chalmers Mfg. Co., Milwaukee, Wis., announces the reelection of all officers and directors at the annual meeting of the firm's stockholders, May 7.

Reelected are: president (for the seventh time), **Walter Geist;** executive vice president in charge of tractor division, **W. A. Roberts;** executive vice president in charge of general machinery division, **W. C. Johnson;** vice president and comptroller, **J. A. Keogh;** vice president and general attorney, **H. W. Story;** secretary-treasurer, **W. E. Hawkinson;** vice president in charge of engineering, **E. H. Brown;** vice president and general sales manager, tractor division, **Marshal L. Noel;** and vice president in charge of sales for general machinery division, **J. L. Singleton.**

Directors re-named are: **J. M. Barker, J. D. Cunningham, A. W. Butler, Hugh Comer, Ernest Mahler, Leigh Willard.**

**Robert F. Nelson,** former vice president and assistant to the president of R. G. LeTourneau, Inc., has been appointed a director and vice president in charge of engineering and manufacturing for American Type Founders, Inc., Elizabeth, N.J.

**George C. Schreiber** has been placed in charge of the Northern Illinois and Wisconsin territories of the Claude B. Schneible Co., and will make his headquarters at 1809 West North Ave., Chicago.

**Fred J. Rutherford** has been appointed a member of the sales staff of Refractories Engineering and Supplies, Ltd., Hamilton, Ontario, Canada. Mr. Rutherford, a member of the Ontario chapter of A.F.A., previously spent five years with the Anglo American Oil Co. in England, and two years in refractory sales in Canada.

**William H. Schuster,** formerly welding engineer, Foster Wheeler Corp., New York, has been appointed welding supervisor, American Car and Foundry Co.

At a recent board of directors meeting of the Grand Trunk Western Railway, **Carl W. Bonbright,** president of the General Foundry & Mfg. Co., Flint, Mich., was elected to fill a vacancy caused by the death of one of the directors.

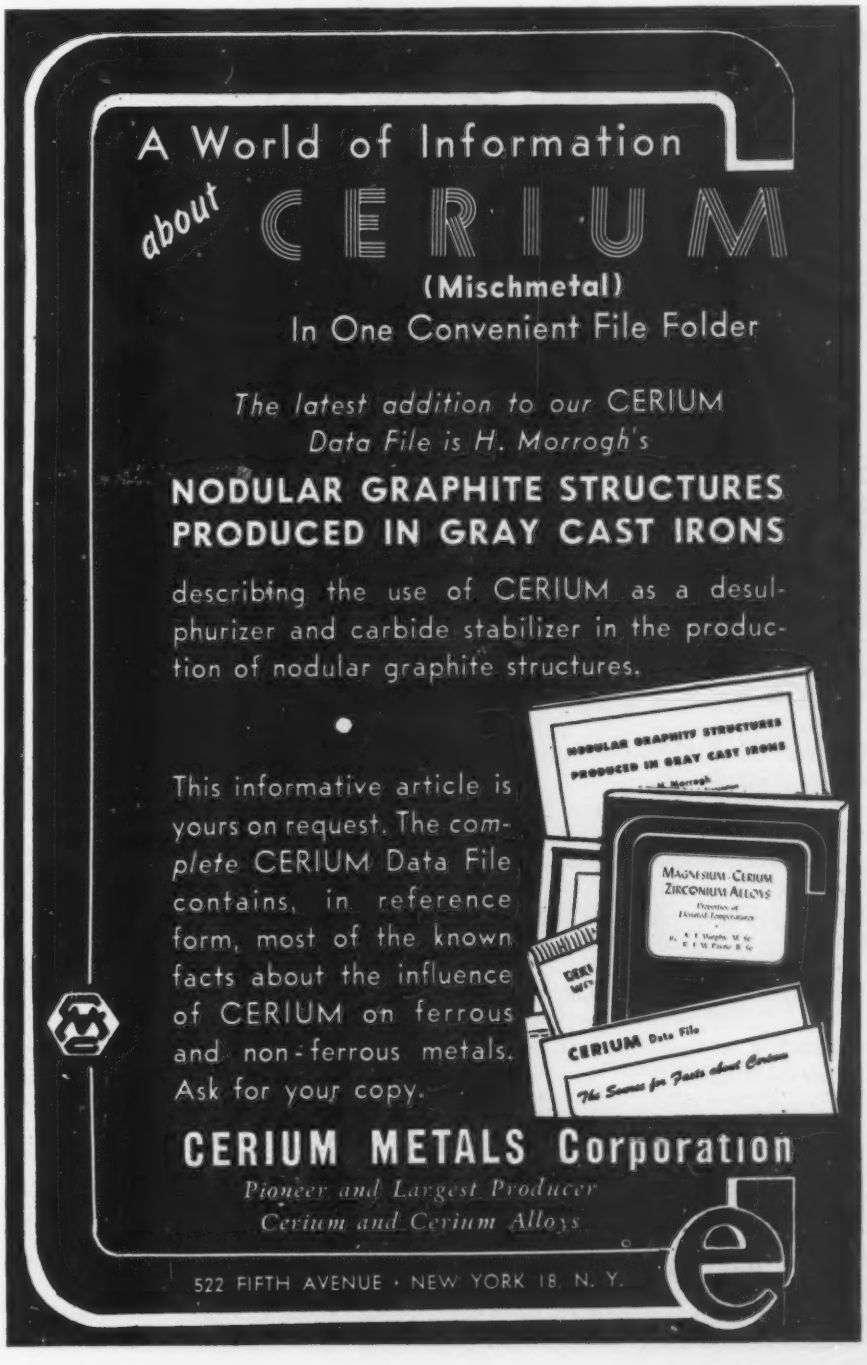
**Dr. John A. Hutcheson,** for four years associate director of the Westinghouse Research Laboratories, has been appointed director, succeeding Dr. L. Warrington Chubb, who is retiring to serve as director emeritus. Dr. Hutcheson directed Westinghouse's extensive wartime radar research program and later the formulation of plans for atomic energy development.

Three new vice presidents elected at a recent meeting of the board of directors of the Hughes Tool Co., Houston, Tex., are **Dan J. Martin, M. E. Montrose and Harry E. Rogers.** Mr. Martin, who becomes vice president in charge of engineering, joined Hughes in 1946 after 22 years Army service. At the time of his retirement he held the rank of Colonel and was executive officer to the Army's Chief of Ordnance.

Mr. Montrose, who becomes vice president in charge of sales, was an executive of the General Electric Co., general manager of the Lane-Wells Co., and prior to joining Hughes in 1946, president and general manager of the Marion (Ohio) Power Shovel Co.

Mr. Rogers, the new vice president in charge of manufacturing, has been man-

*(Continued on Page 89)*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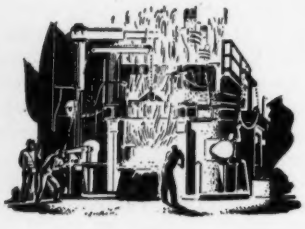

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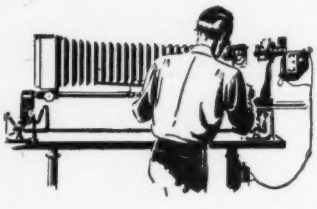

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**MANGANESE** . . . Standard Ferromanganese, Low-Carbon and Medium-Carbon Ferromanganese, Low-Iron Ferromanganese, Manganese Metal, and other Manganese Alloys.

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## PERSONALITIES

*(Continued from Page 87)*

ager of production for Hughes since 1946. Prior to joining the company, Mr. Rogers was works engineer for the Commonwealth Steel Co., and the General Steel Castings Corp., and works manager of the Nordberg Mfg. Co.

**Floyd S. Johnson** is foundry superintendent of the new foundry now being designed for the John Deere Des Moines Works. The new works, formerly the Ankeny Ordnance Plant, is used for fabrication and assembly. The foundry will provide castings for cornpickers and cultivators. Mr. Johnson was formerly foundry superintendent for Fairmont (Minn.) Railway Motors Inc.

## OBITUARIES

**Harry A. Steele,** 71, former owner of the Steele Brothers Foundry, Gloverville, N.Y., died recently in Rutland, Vt.

**Milton S. Finley,** retired manager of the Buffalo, N.Y., territory of the Werner G. Smith Co., died March 17 after a long illness. A pioneer in the development of core oil, Mr. Finley was vice president of the Smith company since its inception. Mr. Finley was a member of the board of directors of the Buffalo chapter, A.F.A.

**Carlisle W. C. Page,** 55, chief chemist of Koppers Co., Inc.'s Blast Furnace and Coke Oven Plant at Granite City, Ill., died March 20. Mr. Page, a graduate of Yale university, served as a lieutenant in World War 1. He was formerly chief chemist with Roberts Ovens, Granite City, and later general superintendent, and in 1938-1940 was chief chemist of the Columbia Steel Co., Provo, Utah. He became chief chemist at the Koppers plant in July, 1941.

**St. John E. McCormick,** 71, founder and president of the Rincon Foundry Co. and president of Central Iron Works, San Francisco, died February 4. Mr. McCormick was a graduate of the University of California.

**Harry Foster Bain, 76,** former director of the United States Bureau of Mines and secretary of the American Institute of Mining and Metallurgical Engineers from 1925 to 1931, died in Manila, Philippine Islands, March 12.

A graduate of Johns Hopkins university, Dr. Bain received a degree of doctor of philosophy from the University of Chicago, and was later editor of the now defunct *Mining and Scientific Press* from 1909 to 1915 and editor of *Mining Magazine*, London, England, for two years. During this period he was on the commission for the Relief of Belgium in World War 1.

Internationally known, Dr. Bain spent much of his life in the Orient and was the author of *"Ores and Industry in the Far East."* Prior to the war, he was consultant to the Philippine Bureau of Mines, and was later interned in a Japanese prison camp in Manila for two years.


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# Cast Metals Handbook

***The Accepted Standard Reference Book for All CAST METALS***

**The complete, accurate and up-to-date reference book on the Engineering Properties of ALL Cast Metals should be among the technical books in every Foundry. Outstanding metallurgists and competent men of industry contributed to it. Committees of technical men helped compile it, from the engineering standpoint.**

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**NOTE**

**"Proper Melting Decreases Foundry Losses," contains interesting data. Also, the booklet, "Nonferrous Ingot Metals of Today." Write for both of these. They are free.**

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In notched waffle sections, or in shot form, Ajax 15% P-Cu does its work at .01% (1 oz. per 100 lbs.). Introduced, and having time to react when stirred with a whirling motion of the skimmer, it causes oxides to rise for effective removal by skimming from the surface. It is best to avoid phosphorus build-up from back stock.* . . If you use phosphorus these days, use Ajax Phosphor Copper (useful also in producing your phosphor bronze)

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## NEW FOUNDRY LITERATURE

**Readers interested in obtaining additional information on items described in Foundry Literature should send requests to Reader Service, American Foundryman, 222 W. Adams St., Chicago 6, Ill. Refer to the items by means of the convenient code numbers.**

**JN101**—Industrial Fabricating, Inc., now has available a 12-page spiral bound foundry equipment catalog illustrating construction details, specifications and applications of its line of flasks and flask equipment.

**JN102**—A catalog of Bay State Abrasive Products, the "Mounted Point—Mounted Wheel Handbook Catalog," contains complete prices and discount tables, and is available free of charge.

**JN103**—A brochure, "Your Production Problems," is designed to acquaint management with the many services offered by The Emerson Engineers. In explaining Emerson services, the booklet is divided into three sections: (1) Three Basic Factors You Manage (Men, Materials, Methods), (2) Case Histories of Production Problems, (3) Particular Comments on Competent Counsel.

**JN104**—A revised 8-page "Buyers' Guide for Ni-Hard Castings," with an abrasion problem questionnaire, is offered by the International Nickel Co. The abrasion problem questionnaire enables the prospective user of Ni-Hard, a nickel-chromium white alloy cast iron, to submit sufficient information on a problem for the company to recommend a suitable material to be used.

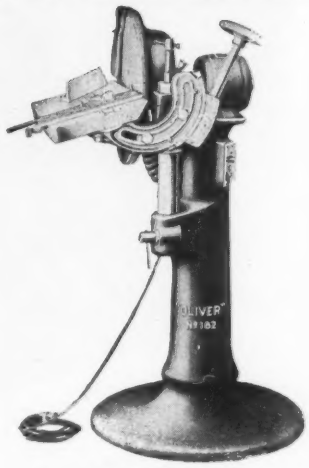
**JN105**—Volume IX, Number One of the *Eaton Engineering Forum*, published by the Eaton Mfg. Co., Cleveland, features an article by A.F.A. Members Richard Schneidewinde of the University of Michigan and Edward C. Hoenicke of Eaton, *"The Chemical, Physical and Mechanical Properties of Permanent Mold Gray Iron,"* comprising results of a two-year study conducted by the University of Michigan's Department of Engineering Research.

**JN106**—Single-sheet bulletins are now available describing the Dings Hold-Tite Electromagnet for holding castings during swing grinding, and the Perma-Pulley Magnetic Separator.

**JN107**—Bulletin No. 48, a condensed catalog illustrating various types and designs of Coleman core and mold ovens, is announced by the Foundry Equipment Co. In addition to the 12 types of ovens described, the bulletin also shows Coleman portable mold dryers for drying molds too large for oven treatment.

*(Continued on Page 94)*

**"OLIVER"**
15-inch
**Disk Sander**



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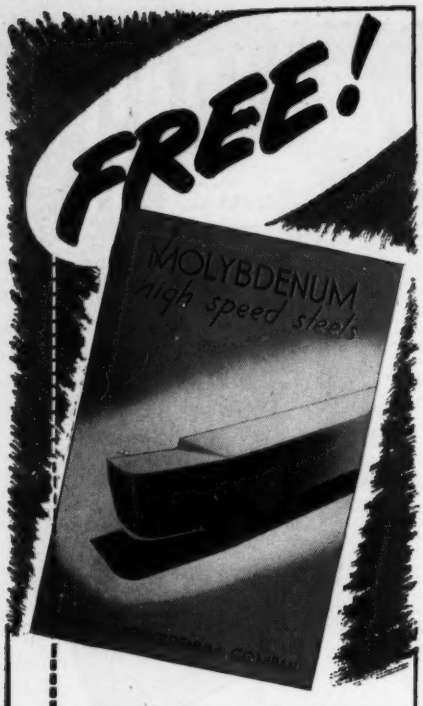


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# NEW LITERATURE

(*Continued from Page 92*)

**JN108**—A Union List of Scientific and Technical Periodicals in the libraries of greater Cincinnati, recently published by the Cincinnati Section of the American Chemical Society, lists the holdings of 58 public and industrial libraries containing some 3200 titles. The 125-page list is available at cost—$2.50.

**JN109**—A four-page bulletin describing the Davis continuous indicating and recording flue analyzer has just been released by the Davis Emergency Equipment Co. The bulletin explains the effect of stack gases on combustion efficiency of fuel, tells how to avoid waste through unburned gases, and how to analyze gases in the stack to insure proper maintenance of combustion at all times.

**JN110**—An up-to-date list of all national standards approved by the American Standards Association is now available free of charge. The list includes such standards of interest to foundrymen and metallurgists as machine tool and parts dimensions, dimensions and identifications of pipes and piping, industrial safety and health, rating and testing of electrical equipment, and definitions, abbreviations and symbols used in technical literature.

**JN111**—*"Magnesium-Cerium-Zirconium Alloys,"* by A. J. Murphy and R. M. Payne, is reprinted by the Cerium Metals Corp., from a November, 1946, article appearing in the *Institute of Metals Journal*, London, England. The 28-page booklet, illustrated with charts and diagrams showing properties of the alloys at elevated temperatures, contains material hitherto not widely available in this country.

**JN112**—*"Modern Trends in Nickel Steel and Cast Iron Gear Materials,"* recently released by the International Nickel Co., is a 20-page pamphlet, illustrated with photos, charts, and diagrams, outlining specifications, properties, and new applications of nickel steel and cast iron.

**JN113**—A new reprint, *"The Use of Gaseous Oxygen in the Metallurgical Process,"* is announced by the Air Reduction Co., Inc. The 12-page illustrated folder offers latest information on the metallurgical uses of oxygen in steel making, with emphasis on open hearth applications.

## FOUNDRY FILMS

**JN114**—A 30-minute illustrated lecture on compressed air power, designed as a teaching aid for engineering schools, is available at cost to industrial organizations, schools and technical groups. "Compressed Air in Action" contains 61 illustrations in either 35 mm continuous strip film or 2x2 film slides. The lecture illustrates modern basic types of air compressor equipment, air operated tools and rock drills and their applications, and has been prepared by the Committee on Engineering Education of the Compressed Air and Gas Institute.


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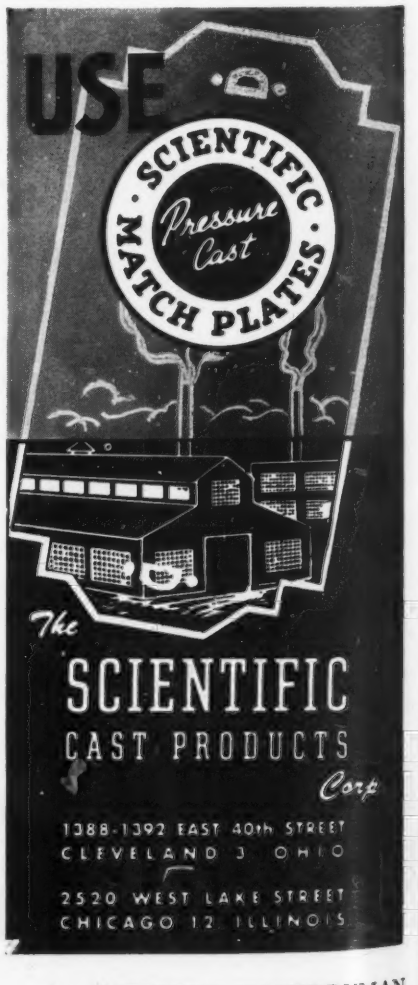

## FIRM FACTS

The **Sturgis (Mich.) Foundry Corp.** was recently issued a permit to erect an $85,000 240 x 60 ft. addition to its plant. The addition will be constructed of concrete and steel.

The **Seminole Iron and Brass Foundry,** recently opened at Seminole, Okla., currently has a six-ton capacity but is expected to produce 25 tons of castings per week in the near future.

**Independent Pneumatic Tool Co.** announces the opening of a new administration building adjacent to its Aurora, Ill., plant. The building, constructed and equipped at a cost of $1,500,000, provides office space, storage space and a machine shop and will house the company's entire executive and administrative staff.

J. J. Nolan, executive vice president of **Central Foundry Co.,** New York, recently paid tribute to Central Foundry's Holt, Ala., personnel in a speech before the Tuscaloosa, Ala., Rotary Club.

Because of the development of a centrifugal method of casting soil pipe known as the Nolan process, Mr. Nolan said, "Central Foundry is better known to foundry people of South Africa, Australia and other nations than it is to residents of Tuscaloosa."

A safety record of 510 days without a lost time accident has been established at the Midland, Pa., plant of the **Mackintosh-Hemphill Co.**

The magnesium foundry operated during the war by the **Dow Chemical Co.** at Bay City, Mich., and a similar foundry at Marysville, Mich., previously scheduled to be auctioned, were recently "frozen" by the War Assets Administration.

**Frank Foundries Corp.,** Moline, Ill., recently established an employee's group insurance program. The plan is a mutual undertaking between employer and employees, with employees contributing fixed amounts and the employer paying the balance of the premiums.

First of the projects to be completed in **Ford Motor Co.'s** Rouge Foundry postwar improvement program is the complete rebuilding of the cylinder block production department at an estimated cost of $12 million. The 1949 Ford and Mercury will have the highest quality and strongest cast alloy steel crankshafts in Ford history because of new foundry methods and controls, Ford officials state.

The **Frankford Arsenal Ordnance Laboratory,** comprising the chemical, metallurgical, mechanical development and ballistics branches, was redesignated the **Pitman-Dunn Laboratory** as of March 10, in recognition of the distinguished service of two Ordnance officers, Capt. John Pitman and Capt. Beverly W. Dunn.


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If foundrymen aren't, it's a miracle. Probably in no other business is there such a seemingly endless number of variables and uncertainties. You can eliminate many of them once and for all by using Semet-Solvay Foundry Coke and Foundry Metallurgists. Let us prove it to you.

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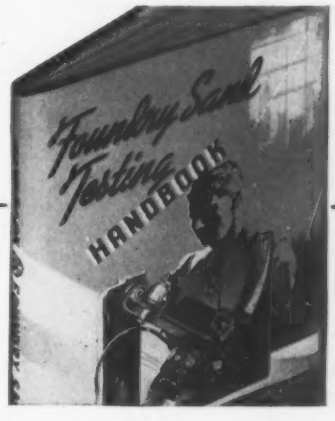


**Foundry Sand Testing HANDBOOK**

A foundryman may select his scrap with the greatest of care. His melting procedure may check with the most advanced practice. And he may exercise full control over his methods. BUT . . . he cannot consistently produce sand castings in molds prepared from uncontrolled sand mixtures.

A casting is only as good as the mold . . . that's why the A.F.A. FOUNDRY SAND TESTING HANDBOOK is a "must" for the foundryman's library. Order your copy today: $2.25 to A.F.A. Members; $3.50 List Price.

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Write for Bulletin 46-B

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Makes metal pure and clean, even when dirtiest brass turnings or sweepings are used. Produces castings which withstand high pressure tests and take a beautiful finish. Saves considerable tin and other expensive metals. Crucible and furnace linings are preserved.

### Famous CORNELL LADLE FLUX

Place a few ounces in bottom of ladle, then tap cupola. Metal is thoroughly cleansed, foreign impurities are easily skimmed off. Ladles are kept clean, there is less patching and increased ladle life. Metal temperatures are retained during transfer to molds.